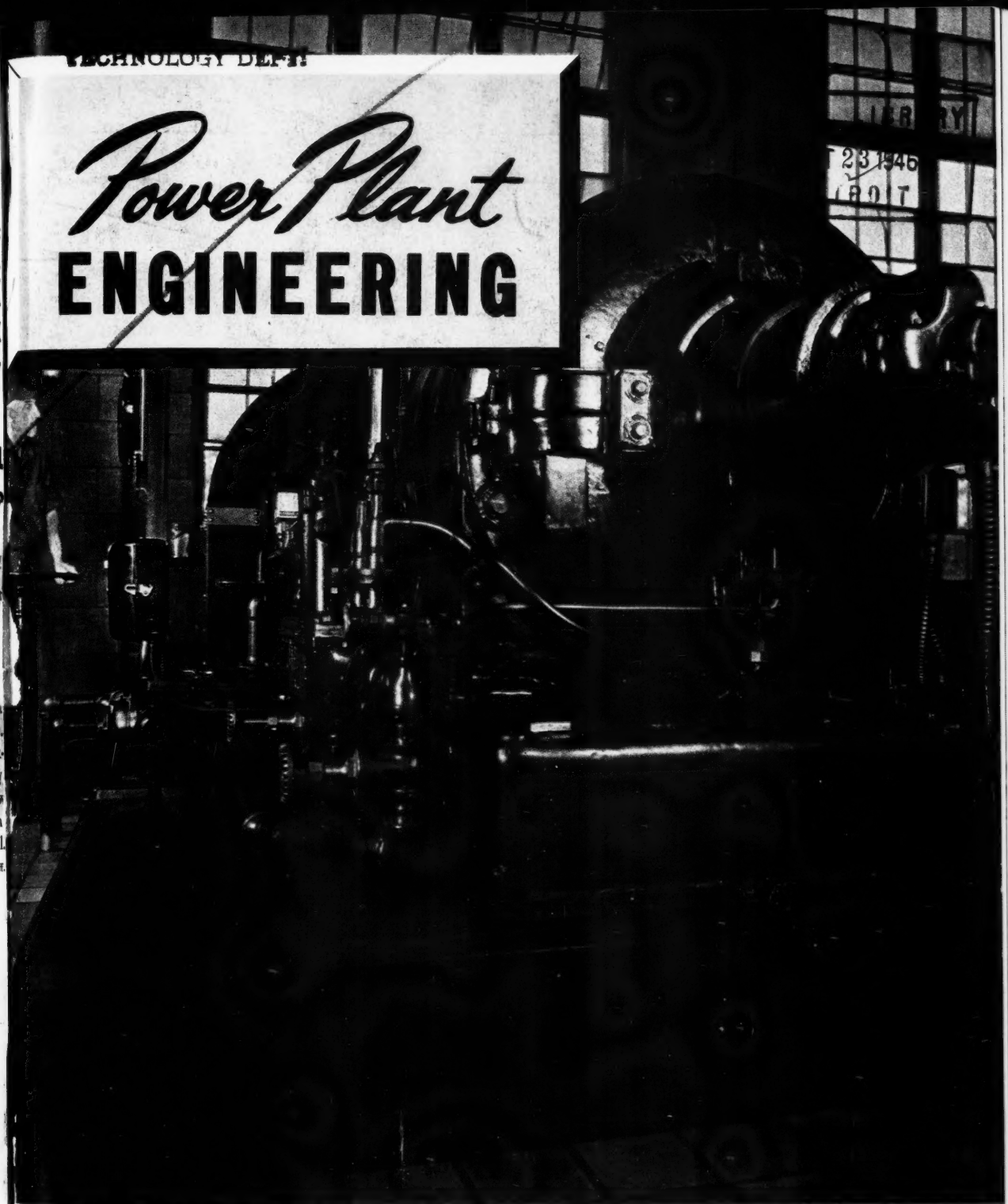
TECHNOLOGY DEPT

Power Plant ENGINEERING



23 1946

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

OCTOBER • 1946

Features

PLANT EQUIPMENT CORROSION • BANKED SECONDARY TRANSFORMER OPERATION • DIAPHRAGM CONTROL VALVE • DIESELS IN STEAM PLANTS • ATOMICS • SPRINGDALE'S 80,000 KW TURBINE • 3 NEW G-M PLANTS • CONTENTS PAGE 5

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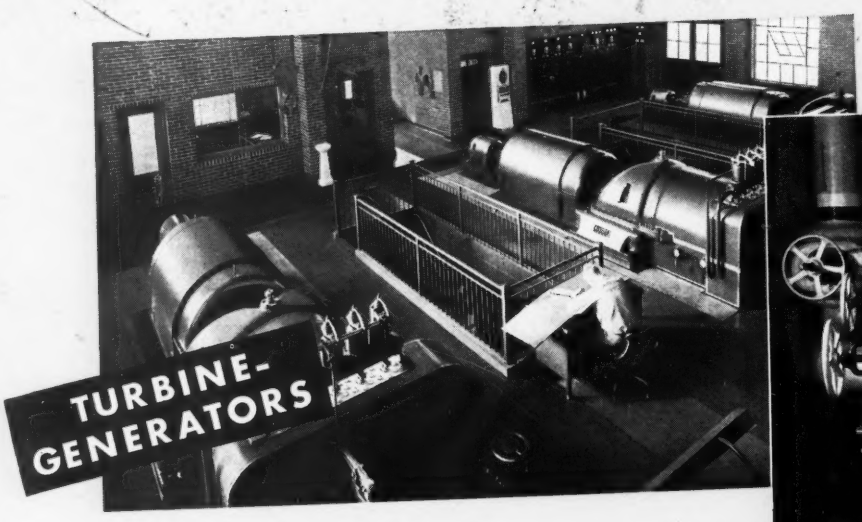

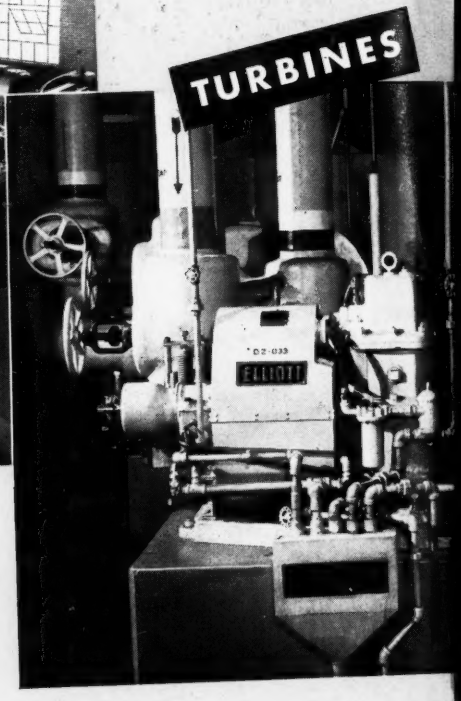

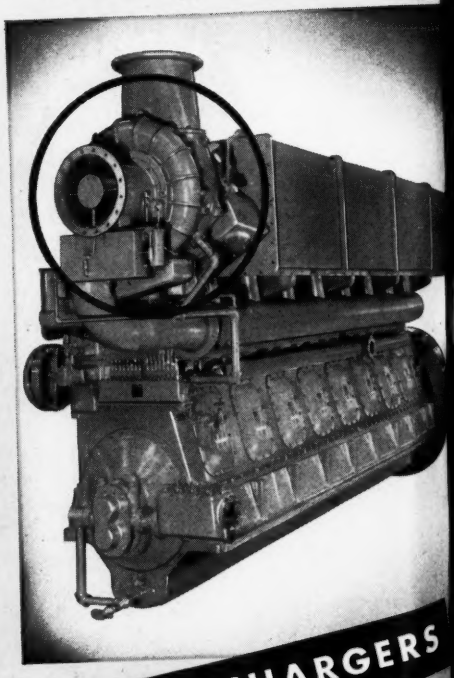

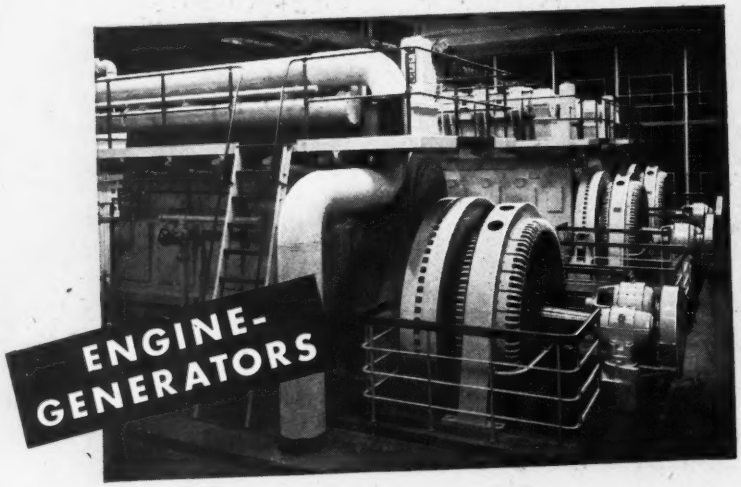

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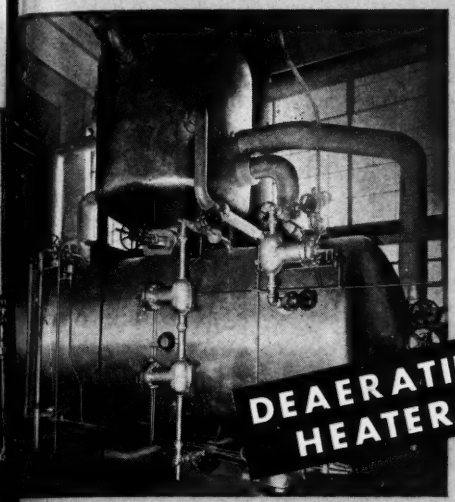

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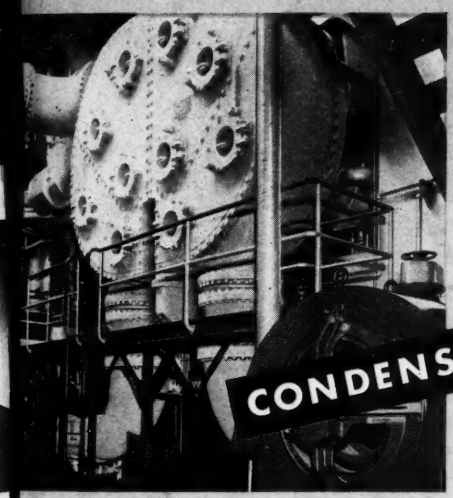

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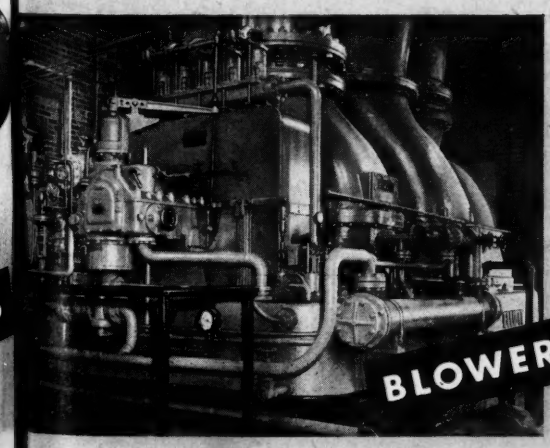

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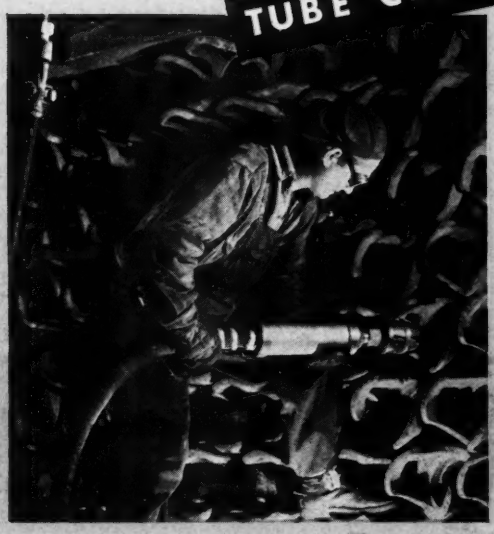

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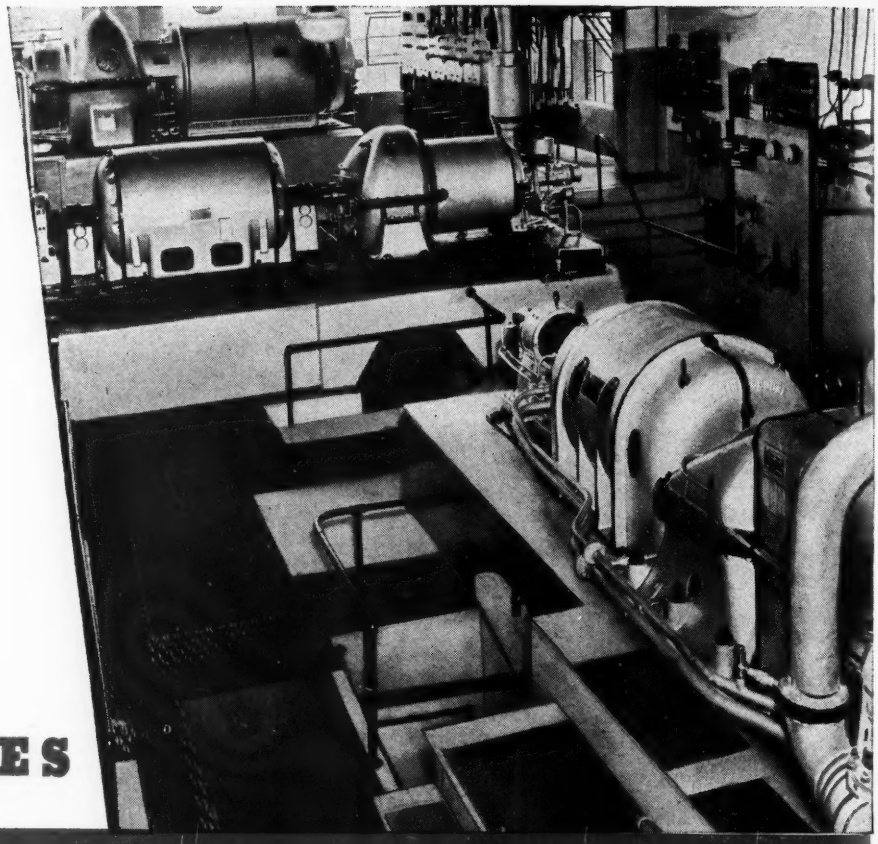

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Power Plant ENGINEERING

October, 1946

VOLUME 50—NUMBER 10

Cover: 400 hp Elliott synchronous motor driving 7000 cfm centrifugal blower at Main Sewage Treatment Plant of Gary, Indiana, Sanitary District.

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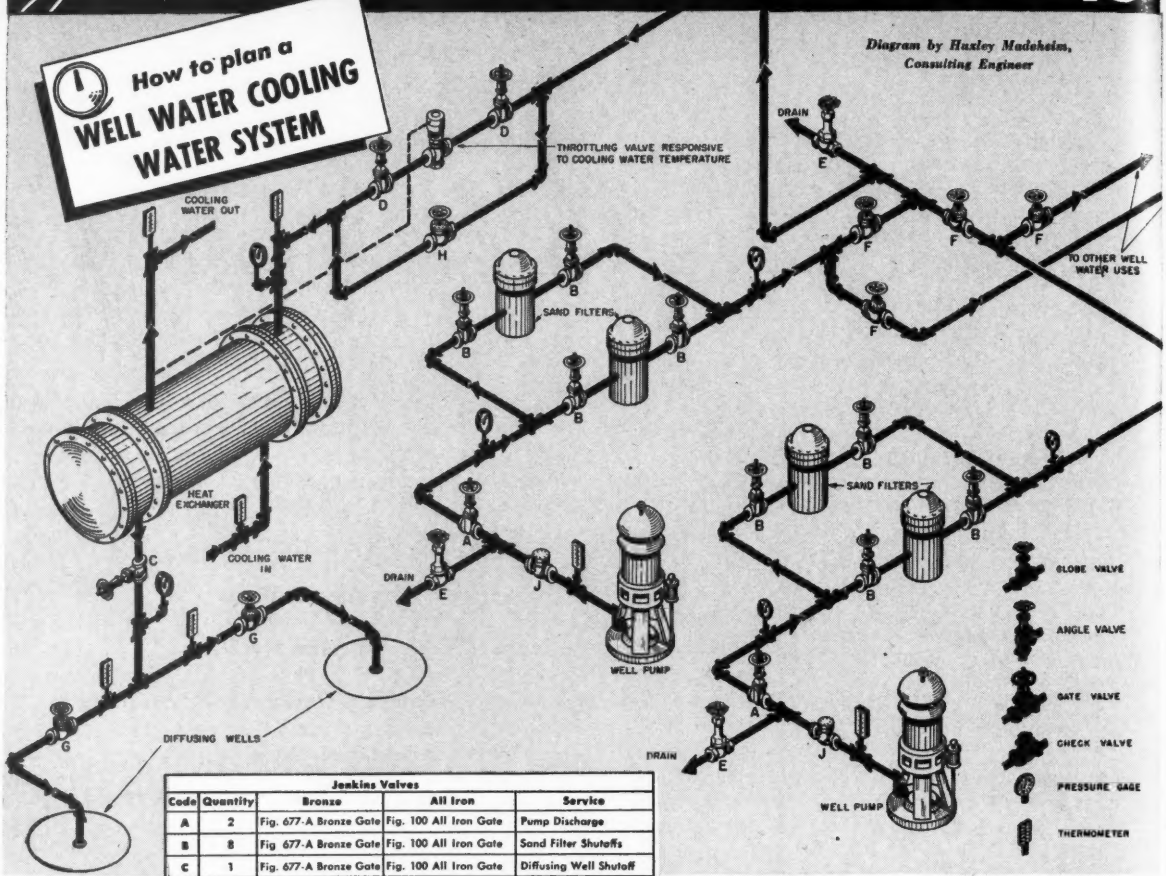
Jenkins PRACTICAL PIPING LAYOUTS 15

How to plan a WELL WATER COOLING WATER SYSTEM

Diagram by Huxley Madeheim, Consulting Engineer



Jenkins Valves				
Code	Quantity	Bronze	All Iron	Service
A	2	Fig. 677-A Bronze Gate	Fig. 100 All Iron Gate	Pump Discharge
B	8	Fig 677-A Bronze Gate	Fig. 100 All Iron Gate	Sand Filter Shutoffs
C	1	Fig. 677-A Bronze Gate	Fig. 100 All Iron Gate	Diffusing Well Shutoff
D	2	Fig. 677-A Bronze Gate	Fig. 100 All Iron Gate	Automatic Valve Shutoff
E	3	Fig. 47 Bronze Gate	Fig. 40-A All Iron U-Bolt Gate	Drains
F	4	Fig. 661 Bronze Globe	Fig. 142 All Iron Globe	Well Water Header Valves
G	2	Fig. 661 Bronze Globe	Fig. 142 All Iron Globe	Diffusing Well Control
H	1	Fig. 661 Bronze Globe	Fig. 142 All Iron Globe	Manual Bypass about Automatic Valve
J	2	Fig. 295 Bronze Swing Check	Fig. 295 All Iron Swing Check	Pump Discharge Check

Water cooling at a lower cost than with cooling towers can often be accomplished with well water, which is available in adequate supply throughout large areas of the nation, at a constant temperature of 50° to 60° in all seasons.

Heat exchangers are frequently used, because of the clogging, scale-forming or corrosive action of many well waters. This confines the flow of cooling water to the tubes, which can be readily cleaned or replaced. Sand filters are included to prevent the carry-over of sand into the equipment. In certain areas the use of a heat exchanger and the return of the water to the ground uncontaminated is mandatory. Such requirements are met by this layout.

Because many well waters rapidly attack some copper base alloys when associated with ferrous metals, all-bronze valves or alternate all-iron valves are listed.

Other types and pressure ranges of Jenkins Valves can be used for this type of layout, according to the factors involved. Consultation with accredited piping engineers and contractors is recommended when adapting these suggestions to your own requirements, or when planning any major piping installation.

VALVE RECOMMENDATIONS

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Front Lines

THE BUILT-IN TRAP idea is a slick trick when you can do it. Building the trap right into the equipment it is to drain does several things. It not only saves the cost of the trap body but also relieves the purchaser of the necessity of buying a separate trap and making additional pipe connections. This is a trick that a good many manufacturers of equipment would do well to look into; it has been successfully worked out by Armstrong.

TAKING THE temperature inside the gas turbine is not an easy job. But a special metal alloy which tells temperature by color has helped G-E engineers solve this problem. The alloy shows a marked color change for every 25-degree change in temperature from 500 C to 700 C, then reverts to its original color and begins the color scale over again in a higher range of from 725 C to 900 C. By making turbine parts of the alloy, the turbine has no alternative but to take its own temperature. Following operation, the alloy has to show the colors and by doing so shows the temperatures reached during operation.

REMEMBER our attempt to be humorous about pumping fish in Front Lines, April 1946, page 7? We received a letter from M. Dwight Bell, consulting engineer, asking for more information about the process of pumping fish because he was wondering if it could be applied to the pumping of cucumbers in a pickle factory. We, of course, referred him to the manufacturers of the equipment involved in the fish pumping operation, Yeomans Brothers Co. The latest report is that they and Mr. Bell are making some intensive investigation of the possibility of handling cucumbers and pickles in this way. Sketches have been made and a tentative outline of two methods proposed for the various handling problems encountered in a pickle factory. Equipment has not yet been purchased but some experimental work has been done to guide the consultant and his client further. It looks favorable but, of course, it will take some time to eliminate whatever bugs turn up as in any other new development. Mr. Bell wants us to make it clear that they have not yet handled any pickles through the fish pump. But they may have more to report soon. One of the principal problems arises from the fact that apparently a cucumber, on its way to becoming a pickle, does not know which end its head is on. A fish is shaped in such a way that he knows which end is his head and which end is his tail, consequently he manages to get himself turned head first so as to enter a fish pump in the proper manner. The cucumber, on the other hand, not knowing which is his head end, may not behave with the same skill and integrity as a fish and may cause a jam in the suction side of the pump. But we shall see.

BERNOULLI CARRIES THE BALL in a new type of valve designed to be self-flushing and have straight line throttling characteristics. Bernoulli, the 18th century mathematician and discoverer of many of the laws of flow, showed that a ball would be drawn to the middle of a flowing stream of liquid by the faster flow and lower pressure at that point. This principle has been used in the new valve, in which a two-throated chamber is used, with a ball that seats against the outlet throat. When this valve is open, a yoke holds the ball down out of the way of the stream flow, giving straight-through and unobstructed flow with very low pressure drop. When the yoke is raised, the stream flow sucks the ball up against its seat, making a line contact seal.

A COMPREHENSIVE bibliography of Scientific and Industrial Reports is now being distributed by the Office of the Publication Board, United States Department of Commerce.

It includes listing of reports on chemical and allied products; electrical machinery, equipment and supplies; fabricated metal products; machinery; products of petroleum and coal; professional, scientific and controlling instruments; and a number of reports on products of consumer goods. The reports will be issued weekly by the Department of Commerce, Office of the Publication Board, on a subscription basis and will be for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

A SMALL AMOUNT of glue is the principal raw material required to make more than a cubic foot of a new type of insulating board announced recently by Foster D. Snell, Inc., consulting chemists and engineers. According to this firm the product called "foamboard" weighs one to three pounds per cubic foot and ranks high among commercial materials in heat insulation properties.

AT A RECENT meeting of the National Industrial Advertisers Association it was announced that *POWER PLANT ENGINEERING* had received the first award silver plaque for the best series of articles entered in the ninth annual competition sponsored by Industrial Marketing. In these articles Managing Editor Andrew W. Kramer discussed the basic facts underlying the atomic bomb; methods used for producing material used in the bombs; possibility of using atomic energy in the production of power; some effects of the bomb on our civilization. One direct result of these articles was the appointment of Mr. Kramer as one of the official press correspondents covering the joint Army and Navy Atomic Bomb Test at Bikini.

SALES OF ELECTRIC power generating equipment are expected to account for 27 per cent of the business of Westinghouse Electric Corp. for 1946. This is in contrast with 1944, when production of central station equipment, under wartime priorities, represented less than 2 per cent of the company's record production of one billion dollars. More than 55 large utilities have placed orders with Westinghouse exceeding half a million dollars each. In some cases, orders have been placed for delivery in 1949, indicating how the utilities plan ahead. Gwilym A. Price, Westinghouse president, said that since this condition is general throughout the heavy equipment industry, it appears that the central station equipment manufacturing units of the nation will be at peak production at least well into 1949. Installed generating capacity in this country today is 51 million kilowatts compared with 44 million in 1941. The Westinghouse economic research department estimates that by 1950 the total will be between 65 million and 67 million kilowatts.

HERE IS A statement made in *The National Provisioner* of May 3, 1919. "The president of the Housewive's League of the United States sent a cablegram to President Wilson in Paris demanding 'help for suffering humanity now staggering under the cruel yoke of prohibitive prices of the bare necessities of life.' She declared that 'we have the greatest stocks of wheat, meat, fats, hogs and cattle that were ever known in the history of the country, yet they are withheld from the people except at prices that none but the rich can pay.' She demanded the enactment of legislation to restrict the export of foodstuffs and provision 'until the people are first supplied at a fair living price.' This was the answer to Herbert Hoover's appeal to help feed starving Europe, which his grain director, Mr. Barnes, declared this week we would have to do for at least a year longer . . . At a time when anarchy and other unsound theories are clamoring for an opportunity to try out experiments, it is necessary to restore 'business as usual' to insure maintenance of peaceful conditions."

TAKE A WELL-intentioned citizen, add a stroke of imagination and a yen for letter writing and you will achieve the blend of personality that contributes ideas for disposal of war-surplus material. Some of the suggestions pouring into the War Assets Administration are truly ingenious according to Mildred Diefenderfer in *Ethyl News*. A great many of them concern the disposal of the Big Inch and Little Big Inch pipelines described in detail in the June 1944 issue of *POWER PLANT ENGINEERING*. There is the fellow from the prairie country who loves the seashore. He'd take the pipelines off the Government's hands and use them to bring the Atlantic Ocean inland. The "Big Inch," he says, could suck in salt water along the New Jersey coast and channel it through a chain of sea-water pools girdling the Middle West, while the stimulating tang of the seashore would be provided by using the "Little Inch" to suck in salt air.

Then there is the citrus fruit fiend who would use these steel arteries to pump grapefruit juice through from Texas to New York. There is a plan to lighten the burdens on the post office by converting the pipe lines into pneumatic mail tubes. An advocate of thermal baths came up with a proposal to transport mineral waters with curative powers to the metropolitan areas of the East. Outstanding among the suggestions was the scheme for running Texas jack-rabbits through the pipe lines on the hoof for consumption in the East. The reasoning behind this is that anything moved far enough becomes a delicacy! The War Assets disposal authorities, considering this plan in their lighter moments, ran up against these problems. What feeding arrangements would have to be made? What incentive could be offered to keep the rabbits running? Who could estimate how many more rabbits would emerge in Linden, New Jersey, than were introduced into the tubes at Longview, Texas? A counsel for Big Inch Gas, Inc., ventured the straight-faced opinion that the rabbits could probably "live on love" during their trip East. Finally the War Assets experts themselves in a moment of relaxation have come up with a fantastic scheme to top all the others. They say why not pour carbonated water into the pipes in Texas, add Bourbon in Kentucky, route the concoction through Pennsylvania's ice mines and arrange suitable terminals in the night clubs in New York City.

"IS IT WRONG to give a man a job—or even part of a job? Should a jobgiver be a second-class citizen?" Allen W. Rucker, veteran of World War I and Gold Star father of World War II thinks not. He has organized the fast-growing Tool Owners Union to restore equal bargaining rights to the 50 million owners of the tools of production and distribution whose savings and investments make our American standard of living possible. The Union seeks to restore the incentive for saving and risk investment in order that the expansion of tools will be at a greater rate than the expansion of our population. Only in this way, the Union claims, can the national per capita scale of living be lifted and the internal and external strength of the nation be safeguarded.

THERMAL CONDUCTIVITY of insulation materials is being investigated in a program designed to provide more accurate and dependable values of thermal conductivity. This has recently been announced by the American Society of Heating and Ventilating Engineers in co-operation with the National Bureau of Standards. Inquiries concerning this program should be addressed to the ASHVE Research Laboratory.

We thrive on the TOUGH ONES!

HE generally comes alone to see you. You called for him because something's gone wrong with a machine or process . . .

Now you tell him about it, and it turns out he knows a lot about equipment just like yours. Nine chances out of ten he can tell you right off what to do. You feel better right away.

And the tenth chance? Well, that's the tough nut. Our man goes away . . . and comes back double! Yes, he brings another man who may be a chemist . . . or a former machine designer . . . or a former shop superintendent . . . but definitely a specialist. These two men between them can almost always fix your tough nut problem.

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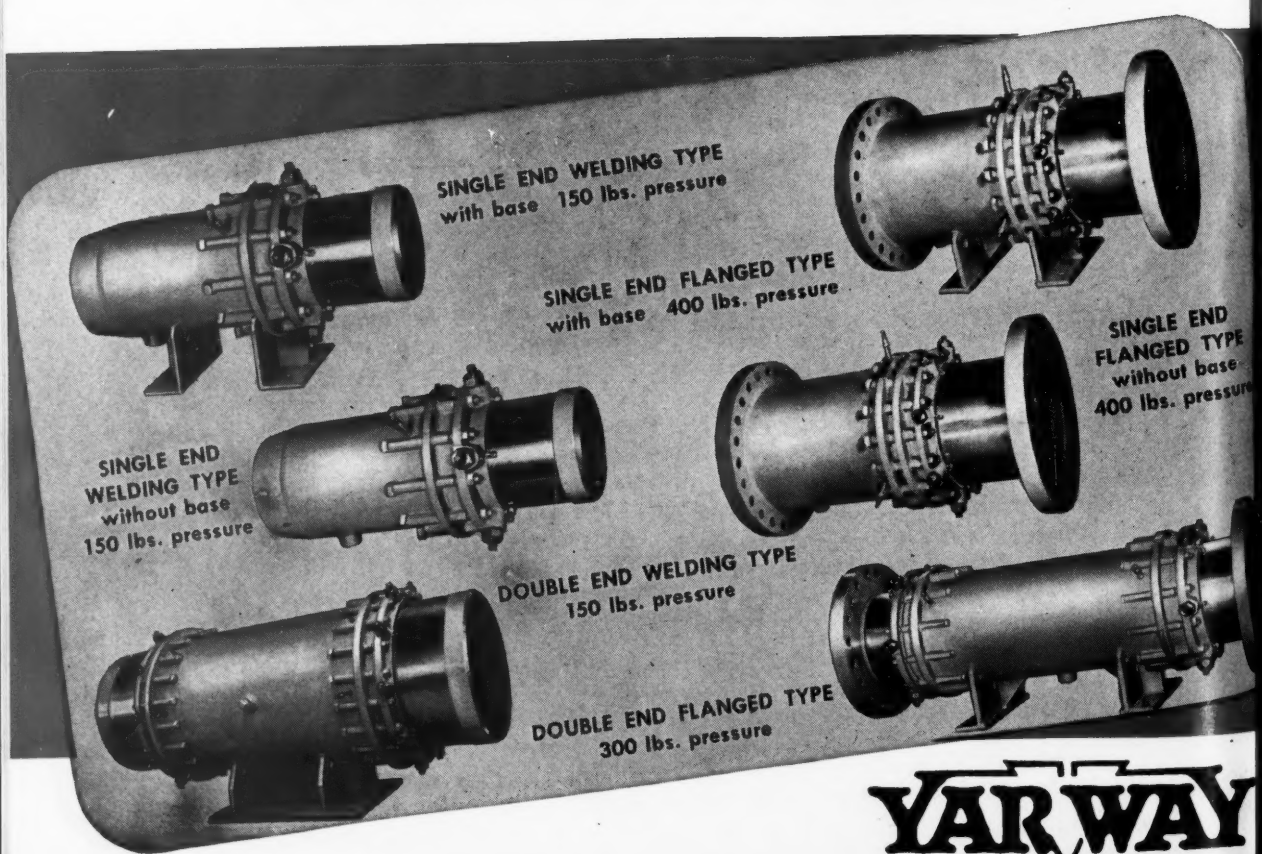

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JOINTS

YARWAY "GUN-PAKT" EXPANSION JOINTS

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"Gun-Pakt" also means minimum maintenance. One user of 66 "Gun-Pakt" joints kept a record for 14 years—the average cost of materials to service joints was only 65 cents per year per joint! Another user, a large utility, maintains over 100 Yarway "Gun-Pakt" joints at a cost of only $1.50 per month for packing for all joints.

No wonder plants like one of Detroit's largest motor car manufacturers are saying, "We want 'Gun-Pakt' joints and nothing else!"

For the full story on Yarway "Gun-Pakt" Expansion Joints, write for Bulletin EJ-1911.

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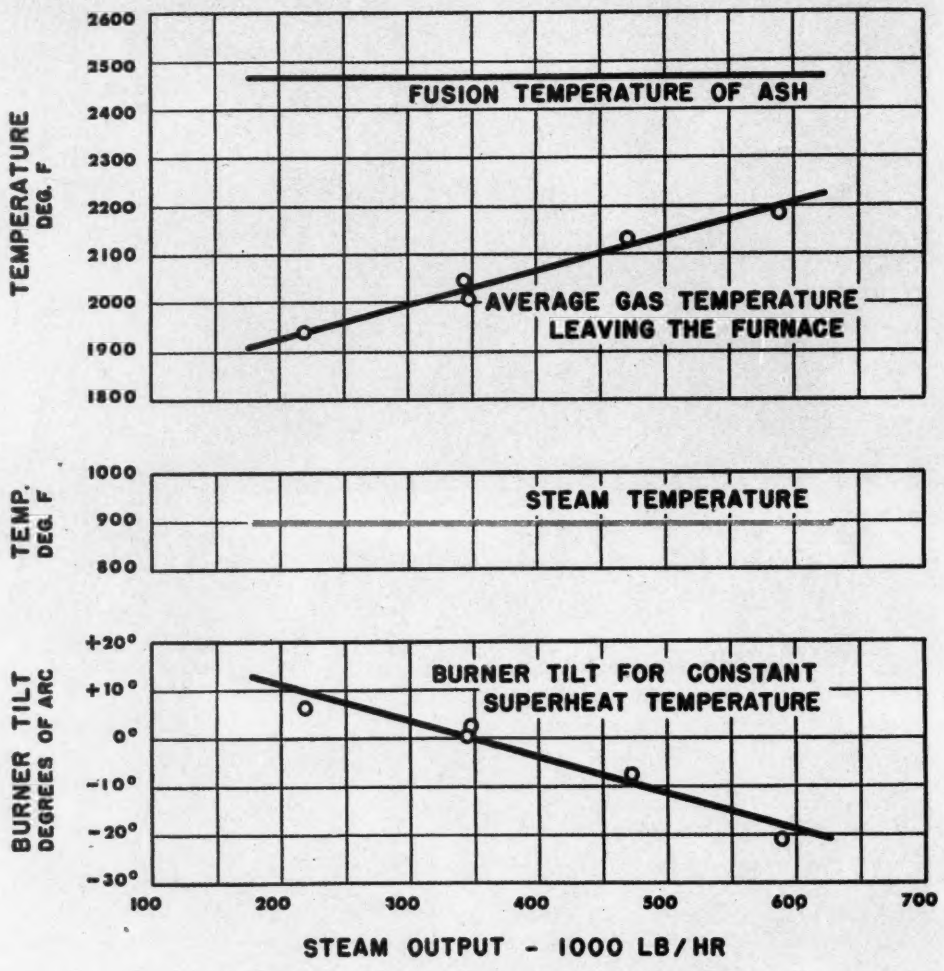
GUN-PAKT EXPANSION JOINTS

Furnace Temperature



This chart was plotted from data obtained through a series of exhaustive tests recently conducted at Plant Atkinson of the Georgia Power Company. Although the C-E Steam Generating Unit under test was equipped with a bypass damper for close control of final superheat temperatures, these results are obtainable by means of burner adjustment alone. Under routine operation, however, the bypass damper may be counted upon to provide the final "vernier" control.

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

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Two important advantages are achieved: (1) control of furnace heat absorption and therefore furnace temperatures, and (2) wide range control of superheat temperature.

TODAY'S most difficult problem in the design of a high pressure, high temperature steam generating unit is *temperature control.*

It is not difficult to design a unit to deliver superheated steam of proper temperature at *one* load point and for a *given* fuel. But virtually every steam generating unit must be designed for variable load conditions — many for a wide range of capacities — and most units must be designed for variable fuel quality as well.

The answer is *furnace temperature control,* i.e. the ability to regulate, at will, the temperature of furnace gases as they enter the superheating surfaces. There is only one known way to accomplish this effectively — Tangential Firing with Vertically Adjustable Burners which provides, in effect, an Adjustable Furnace.

The panel at the left briefly describes how the Adjustable Furnace operates to achieve furnace temperature control. Confirmation of its effectiveness is shown by the chart of test results appearing on the opposite page.

A-993

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ASBESTOS IN ACTION

● APAC, used as exterior siding on this huge administration building, combines up-to-the-minute design with maximum durability. Design and Construction by The Austin Company.

Whether your plans include remodeling or new construction, here are 3 compelling reasons why K&M "Century" APAC sheet material is the *right* material to use.

1. APAC IS VERSATILE

Furnished in 4′ x 8′ sheets 3/16″, 1/4″, 3/8″ thick, APAC is easily adaptable to outside sheathing, office panelling, partitions, elevator shaft casings, stock rooms and storage bins . . . in fact APAC has as many uses as a building has surfaces.

2. APAC IS PRACTICAL

Compounded of asbestos and portland cement, APAC is completely fire-resistant, rot-proof, vermin-proof and termite-proof. It makes a neat-looking job and will never deteriorate. Time only toughens it.

3. APAC IS ECONOMICAL

First cost is low, and APAC is so easy to cut, handle and apply that it lowers the cost of construction. Once it's on, APAC lasts indefinitely, without maintenance or protective painting.

• • •

If there's anything else you want to know about this remarkable building board, we'll be glad to give full details. Just call or send us a card.

Nature made Asbestos . . .
Keasbey & Mattison has been making it serve mankind since 1873.

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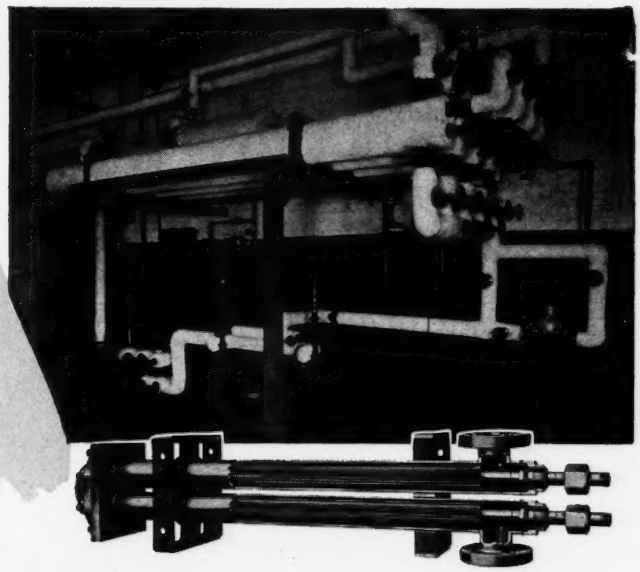
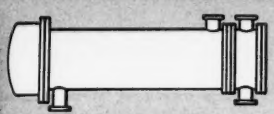
TWIN G-FIN SECTION FUEL OIL HEATER



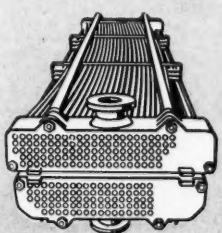
ONLY G-R BUILDS THIS WIDE VARIETY OF HEAT TRANSFER APPARATUS



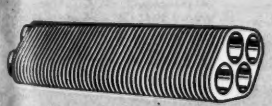
SHELL and BARE TUBE
Heaters, Coolers, Condensers, Heat Exchangers

G-FIN
Longitudinal-finned elements for greater heat conductivity

K-FIN
Helical-finned elements for vapors and gases



BENTUBE EVAPORATOR
Scale-shedding Elements



TUBEFLO SECTIONS
Non-clogging design for residuum and other dirty fluids

Simple

Just a pipe within a pipe—that's the principle of the Twin G-Fin Section. The G-Fin inner pipe, through which the steam passes, has longitudinal fins to provide greater surface for transfer of heat to the oil flowing through the outer pipe.

Readily Installed

The Twin G-Fin Section is easily handled, and can be placed close against a wall, ceiling or floor . . . wherever most convenient. Movable supports further assist convenient installation.

Easy To Clean

The G-Fin heating elements or pipes may be completely removed from the shells for cleaning, without disturbing the oil connections. No special tools are required.

Flexible Capacity

These units are standard and interchangeable. They may be arranged in series or parallel; and at partial loads, sections may be cut in and out to maintain constant oil temperature.

Compact

The longitudinal G-Fins provide at least six times as much heat transfer surface as bare tubes . . . the result: the Twin G-Fin unit has fewer tubes than any other type of heater.

Leak-proof

Leakage between steam and oil cannot occur because there are no internal joints.

For complete description of this superior fuel oil heater, write for our Form 714.

THE GRISCOM-RUSSELL CO.

285 Madison Ave., New York 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

factory representatives

Abbey Steam Spec. Co.
Atlanta 3, Ga.
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Birmingham 1, Ala., Southeastern Prod. Corp.
Boston 10, Mass., Files Steam Spec. Co.
Brazil, Hero Hidroelectica, Caixa Postal 2835, Sao Paulo
Brockton 2, Mass., Corcoran Supply Co.
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Buffalo 15, N. Y., Herr Steam Spec. Co.
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Charleston H, S. C., Charleston Supply Co.
Charleston 26, W. Va., Baldwin Supply Co.
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Chile, S. A., Gregorio Kogan, Casilla de Correo No. 594, Valparaiso
Christchurch, C. I., New Zealand, Vale & Co., 141-3 Armagh St., (P.O. Box 1050)
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Sao Paulo, Brazil, S. A., Hero Hidro-electrica, S.A., Rua Florencio de A 610 (Caixa Postal 2835)
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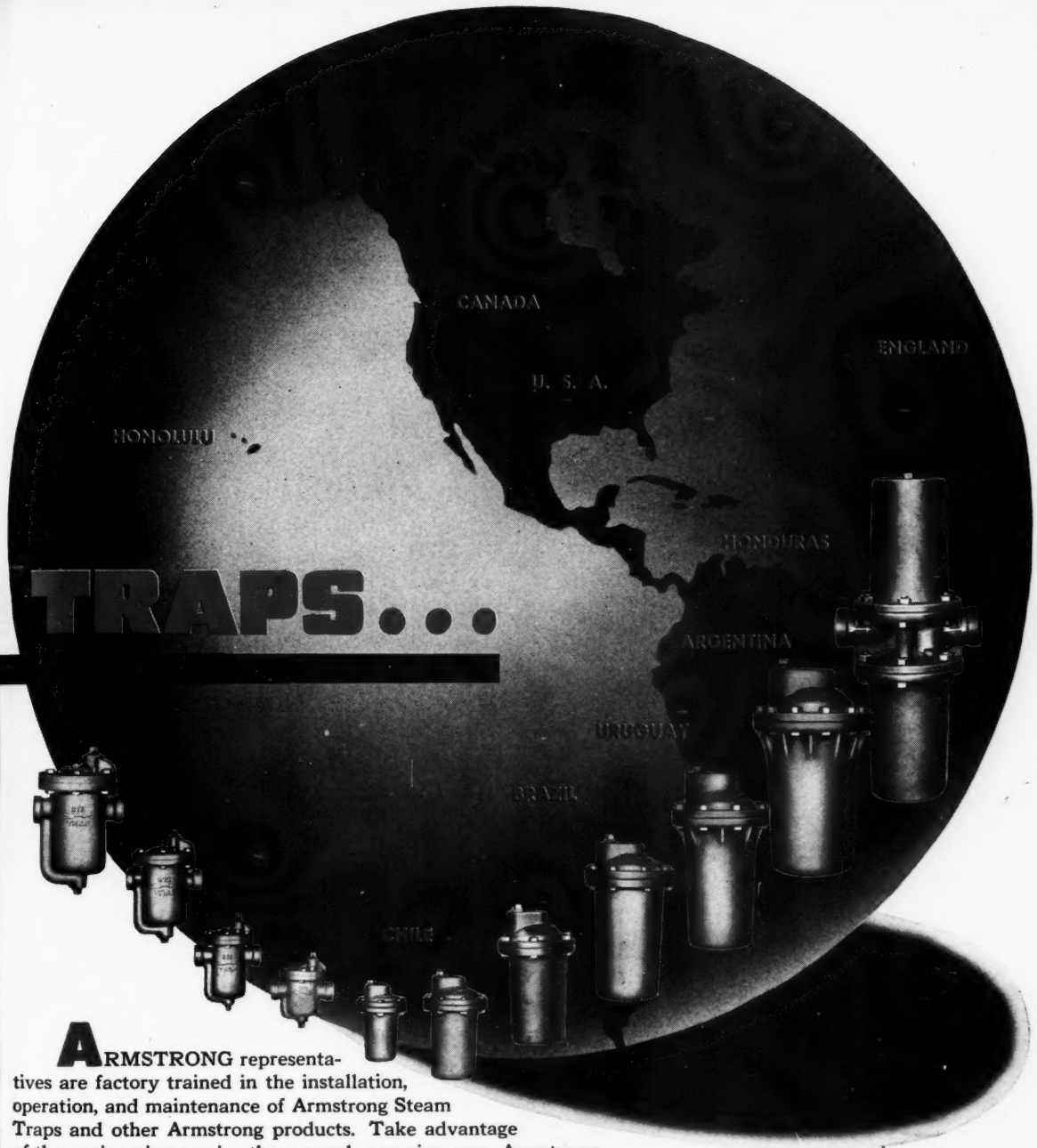

TRAPS...

ARMSTRONG representatives are factory trained in the installation, operation, and maintenance of Armstrong Steam Traps and other Armstrong products. Take advantage of the engineering service these people can give you. Armstrong stock jobbers, likewise, have been selected to extend facilities to virtually every industrial center in the United States and Canada. Overseas, similar care has been taken in appointing agents who have outstanding sales, service, and engineering facilities. This is another reason why it pays to standardize on Armstrong Traps — more than a million in service throughout the world!

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Maple Street • Three Rivers, Michigan

Complete Penetration

to ROOT of BUTT WELDED JOINTS*

Controlled, Two Stage Welding by the Westport Method now provides maximum bondage and strength at butt welded pipe joints, without "over-welding," which causes protrusion of weld metal on the inside of the pipe. The patented Westport Method assures a pipe contour smoother on the inside than on the outside, without the use of backing rings, which themselves have many disadvantages. . . . Our bulletin "Something New in Welding" tells the complete story. Write for it today. And remember, while our shop pre-fabricated piping can be made with any type of joint, we believe you'll prefer and specify the Westport, after you read our bulletin.

WESTPORT JOINT

(PATENTED)

*MADE WITHOUT BACKING RINGS BY THE MITCHELL-WESTPORT METHOD

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SINCE 1899

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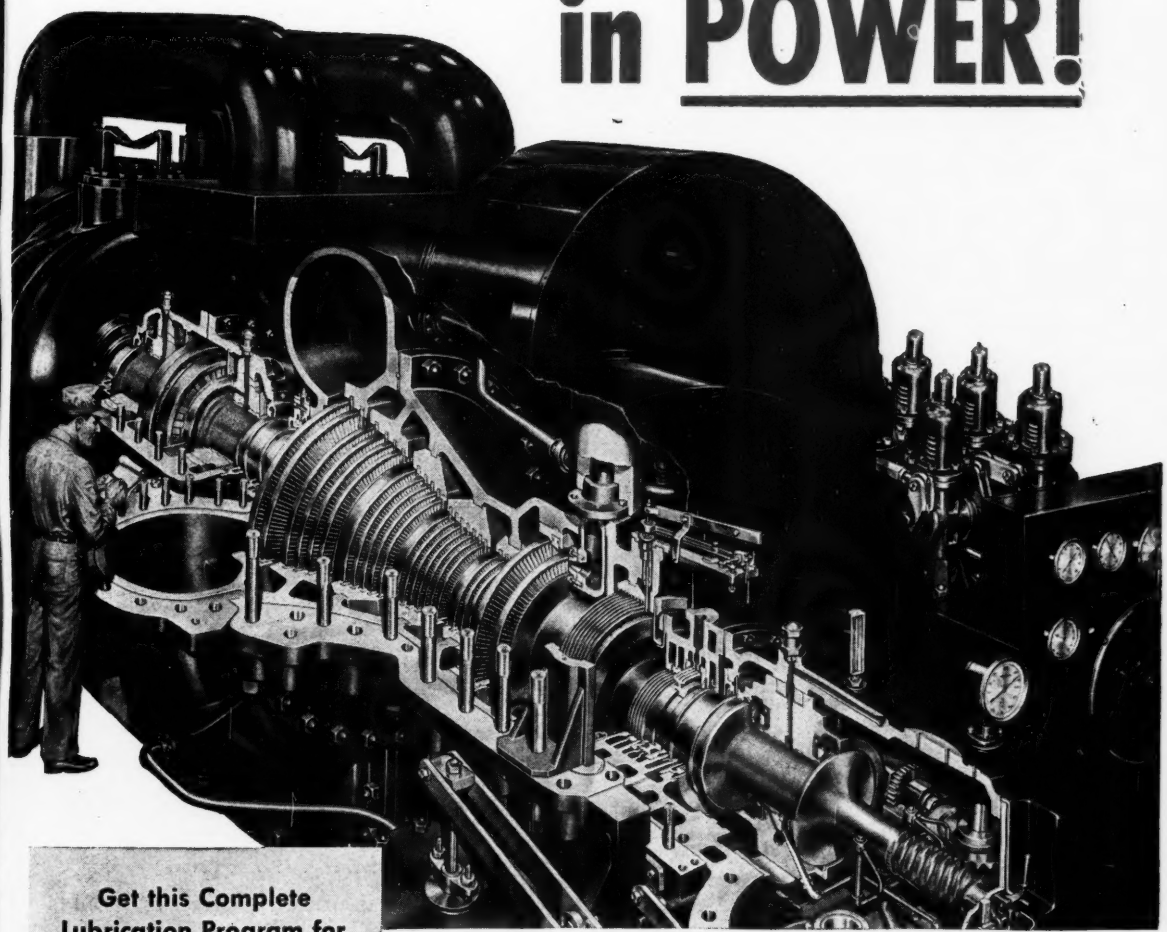
PIPING FABRICATORS AND CONTRACTORS

Proof of a Payoff in POWER!



Get this Complete Lubrication Program for all your machines

- Lubrication Study of Your Entire Plant
- Recommendations to Improve Lubrication
- Lubrication Schedules and Controls
- Skilled Engineering Counsel
- Progress Reports of Benefits Obtained

● To get more power out of every ton of coal, turbine manufacturers have boosted the speeds, pressures and temperatures inside modern machines like this. Today, steam pressures have reached beyond 2,000 pounds per square inch. Temperatures have soared as high as 940° F.

This stepped-up temperature has posed a difficult problem for lubricating oil. To meet it, four years ago Socony-Vacuum developed a great new turbine oil and placed it in turbines where other oils had been deteriorating to the point of failure in short periods of time.

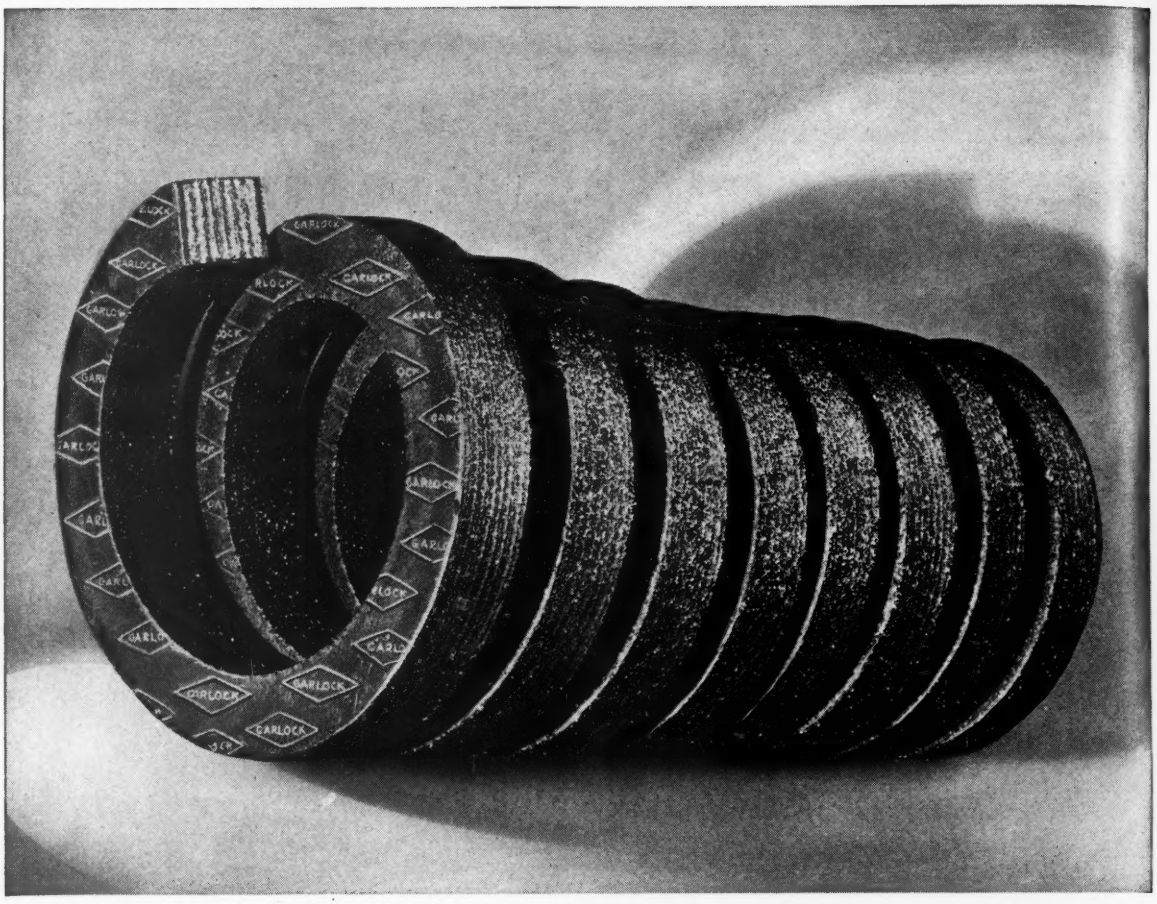
The new oil is now giving record-breaking performance in all of these turbines. Analyses show negligible change . . . or no change at all . . . after months and even years in this severe service.

This means more constant, dependable power output and lower ultimate lubrication costs . . . important factors not only for turbines, but also for every other machine. Socony-Vacuum's complete lubrication program assures these benefits for your entire plant. Get this program now for a payoff in production and profits.

Mobilgas Mobiloil Lubricants

Socony-Vacuum Oil Co., Inc.

and Affiliates: Magnolia Petroleum Co., General Petroleum Corporation



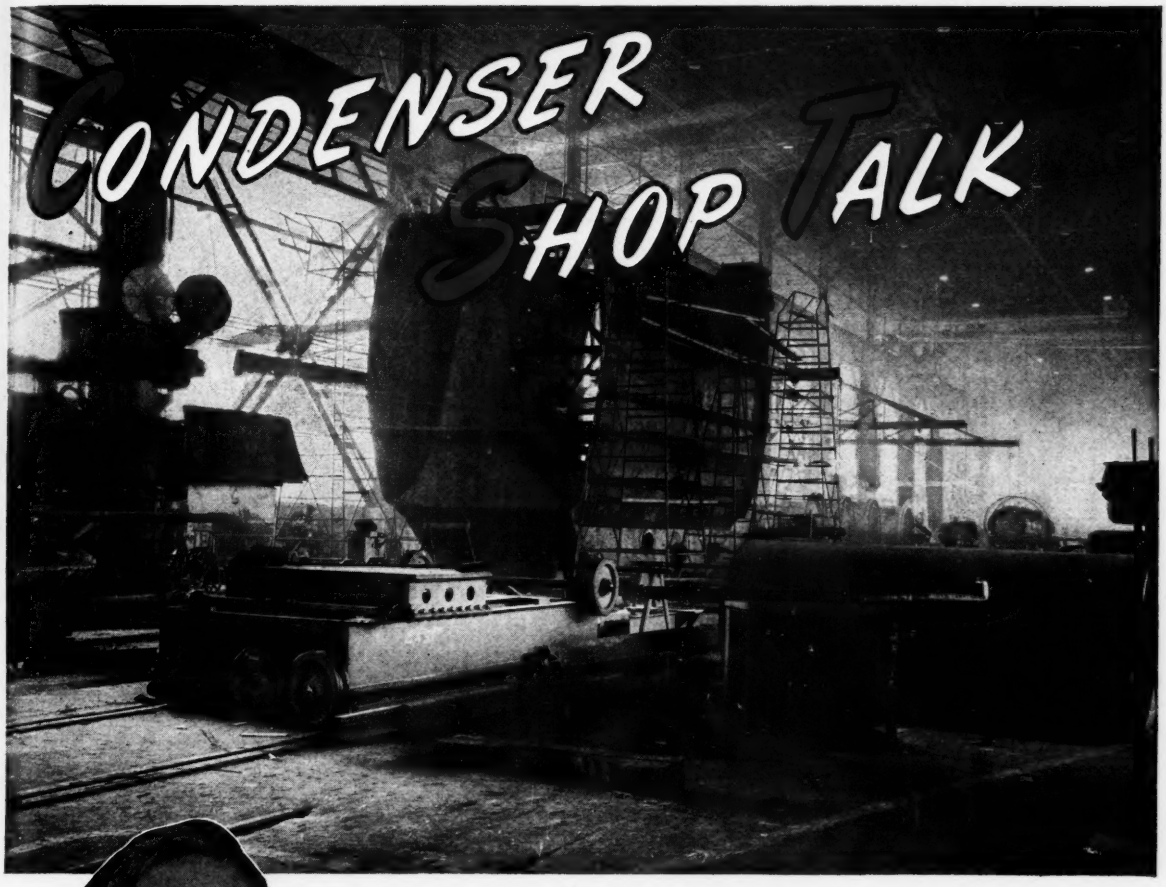
"An Excellent Low Pressure Packing"

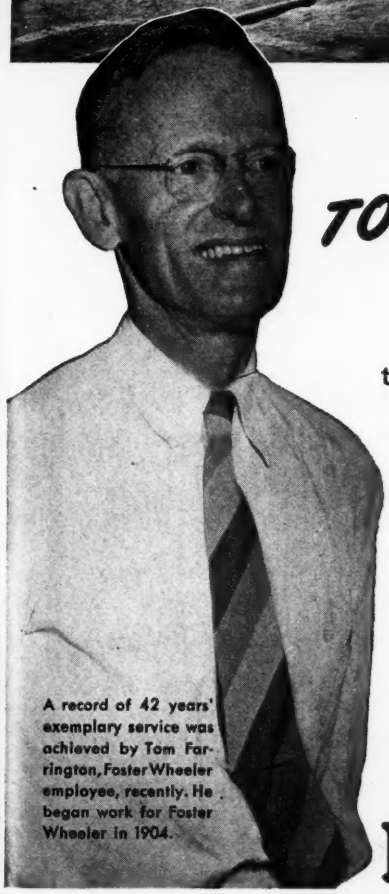
GARLOCK 777 Spiral illustrated above, for hot and cold water, and low pressure steam. (For ammonia specify GARLOCK 778) Ring form—GARLOCK 333 for water and steam—and GARLOCK 334 for ammonia.

THAT'S a typical comment from thousands of engineers who have used GARLOCK 777 for many years. It is the accepted standard rubber and duck packing for hot and cold water, and for low pressure steam. Use GARLOCK 777 on piston and valve rods of engines and on rods and plungers of reciprocating pumps.

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.
In Canada: The Garlock Packing Co. of Canada, Ltd., Montreal, Que.

GARLOCK 777





A record of 42 years' exemplary service was achieved by Tom Farrington, Foster Wheeler employee, recently. He began work for Foster Wheeler in 1904.

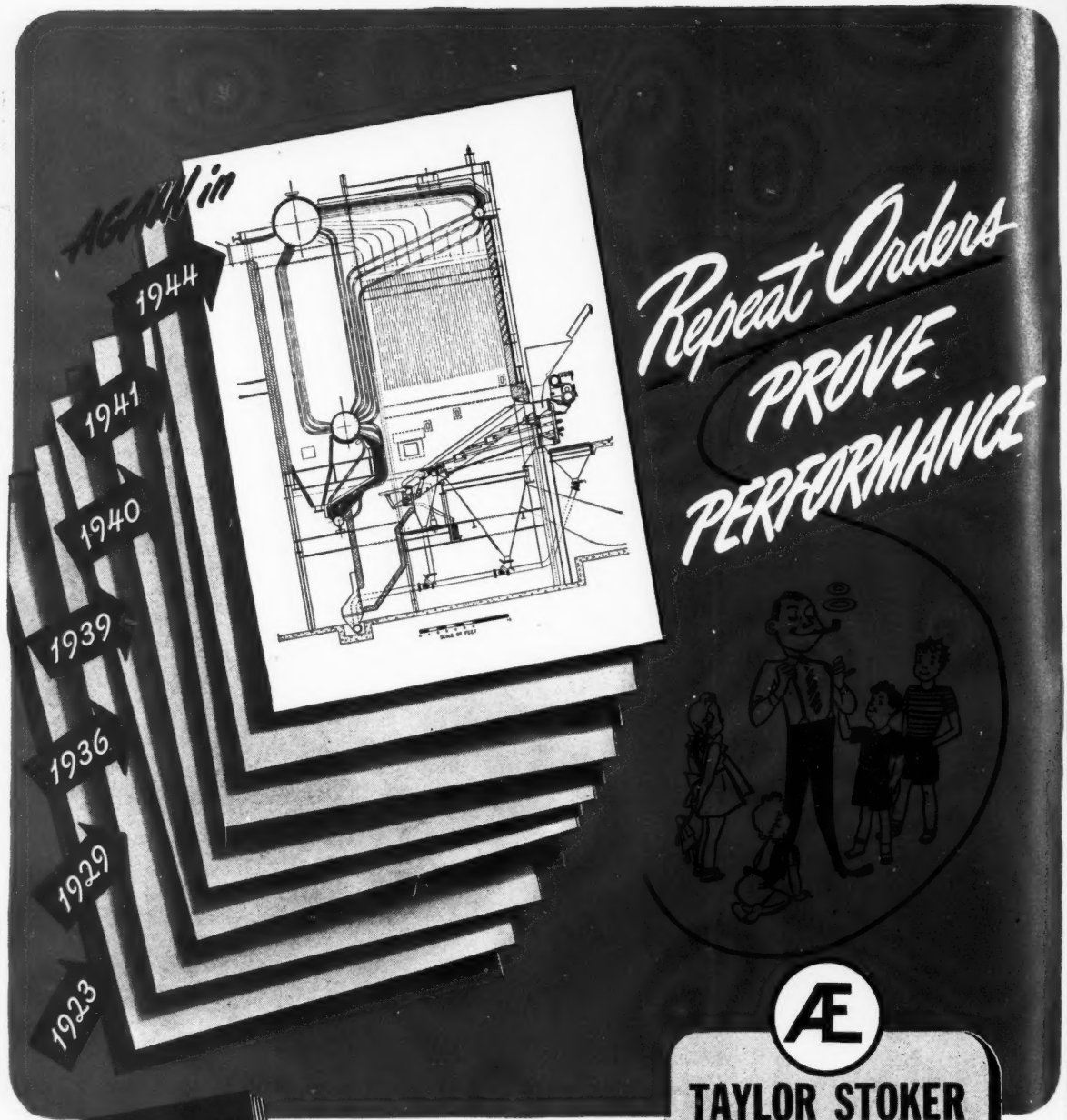
TOM FARRINGTON SAYS:

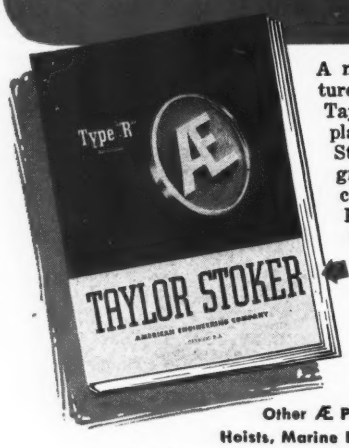
"After 40 years I've just heard of two old friends and they are still in the best of health. Seriously, these friends are two FW condensers built in 1906, and I have an order for some minor repairs for them. I understand they are still doing a fine job."

The point is: the Foster Wheeler Repair Department receives orders for repairs to FW equipment installed over 40 years ago—and still going strong. Often the men who built the equipment will direct the repair work. That's the service FW offers.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER





A nationally known automobile manufacturer has consistently generated steam with Taylor Stokers since 1923. In the various plants of the company a total of 26 Taylor Stokers are in use. Naturally, when greater capacity was needed recently, this company turned to the new Taylor Type R Stoker which increased steam generation to a total of 1,500,000 lbs. per hour.

GET THE FACTS ON THE IMPROVED TYPE R

This easy-to-read 18 page bulletin will quickly bring you up-to-date on the advantages and improvements in stoker operations as provided by the AE Taylor Stoker. Write for it!

TAYLOR STOKER

AIR-COOLED & WATER-COOLED

The Only Underfeed Stoker with *all* these Features IN COMBINATION!

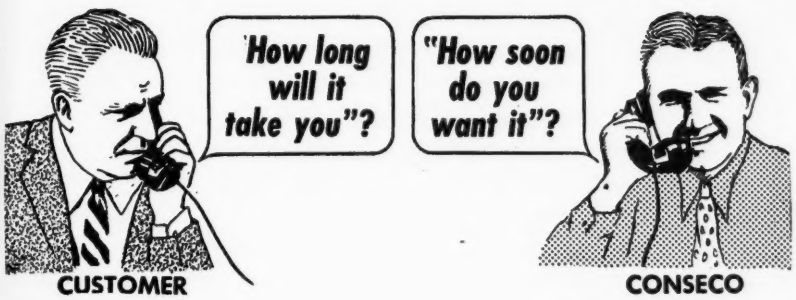
1. Continuous Self-Sealing Ash Disposal
2. Movable Ash Discharge Plates
3. Smooth-Flow Hydraulic Drive on Rear End
4. Independent Pusher Controls within ⅛ inch
5. Unique Sure-Feed Coal Agitators
6. Silent-Shift Spur Gear Planetary Power Transmission

Other Æ Products: Æ-Perfect Spread Stoker, Lo-Hed Hoists, Marine Deck Auxiliaries, Hele-Shaw Fluid Power.

AMERICAN ENGINEERING COMPANY

2406 ARAMINGO AVENUE, PHILADELPHIA 25, PA.

In heat exchanger design, fabrication, and maintenance
We do the "impossible" regularly



If you need fast delivery or maintenance service on any tubular equipment, the pictures above provide a quick answer to your problem. Our files are full of "impossible" jobs we performed satisfactorily, economically, and on or before the time promised.

Conseco and its subsidiaries have vast facilities for rapid design and fabrication of all types of tubular equipment and accessories listed here. We also redesign, rebuild, retube, and maintain any tubular equipment, whether made by us or by others. Our highly-trained maintenance crews, equipped with special time- and labor-saving tools, are ready for instant action any time, day or night, anywhere on the continent. Send for bulletins covering the equipment or service in which you are interested.

Products and Services

Boilers—Bent or straight tube
Condensers and Accessories
Air and Erosion Eliminators,
Fibre plugs,
Injectors (Stop leaks),
Packing,
Tube inserts, metal or plastic.
Coolers
Evaporators
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Steam Jet Air Ejectors
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Redesigning, rebuilding, retubing any tubular equipment.
Superheaters, water walls, economizers designed and built into any boilers.
Tubes tested without dismantling by Hydro-dynamic method. Patented.
Tubes stretched.
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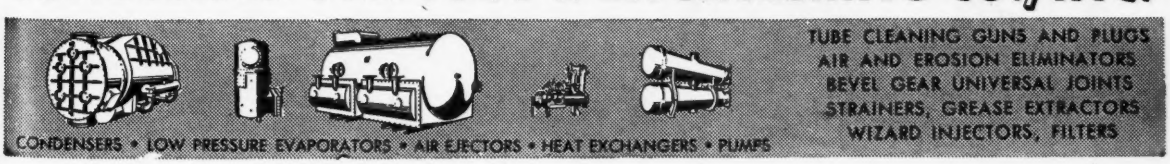
Metal spraying.

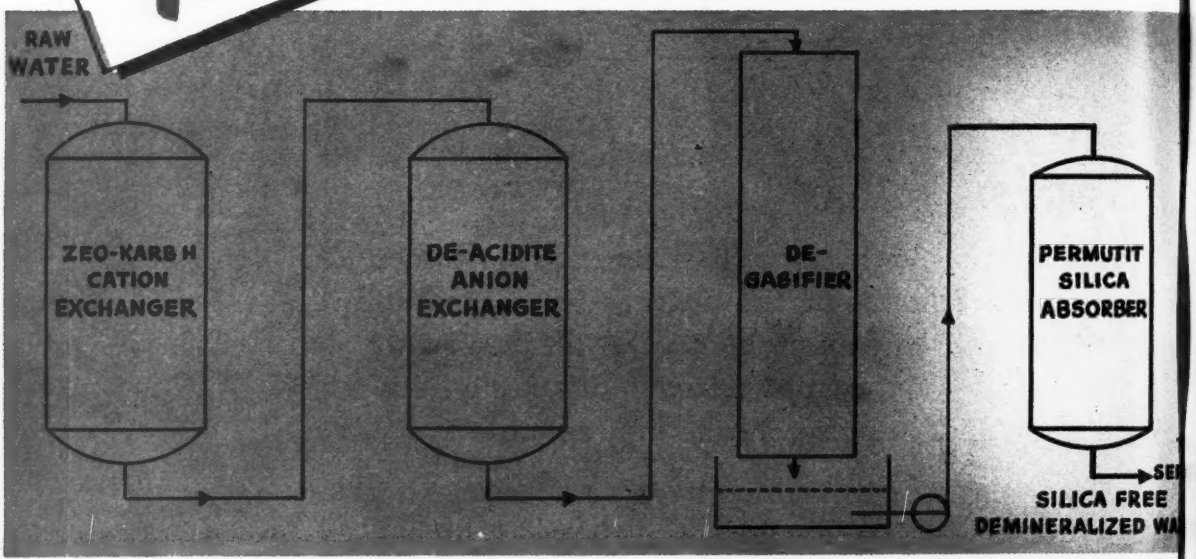
A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.

CONDENSER SERVICE & ENGINEERING CO., INC.


TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS
CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TWO REVOLUTIONARY

1. SILICA REMOVAL combined with DEMINERALIZATION!



HERE'S AN ECONOMICAL NEW CHEMICAL PROCESS FOR PRODUCING THE EQUIVALENT OF DISTILLED WATER!

The Permutit* two-step De-mineralizing process utilizes Zeo-Karb H, Permutit's acid-regenerated cation exchanger to replace metallic cations with hydrogen ions, converting salts present into corresponding acids. These acids are then removed from solution by De-Acidite, Permutit's resinous anion exchanger.

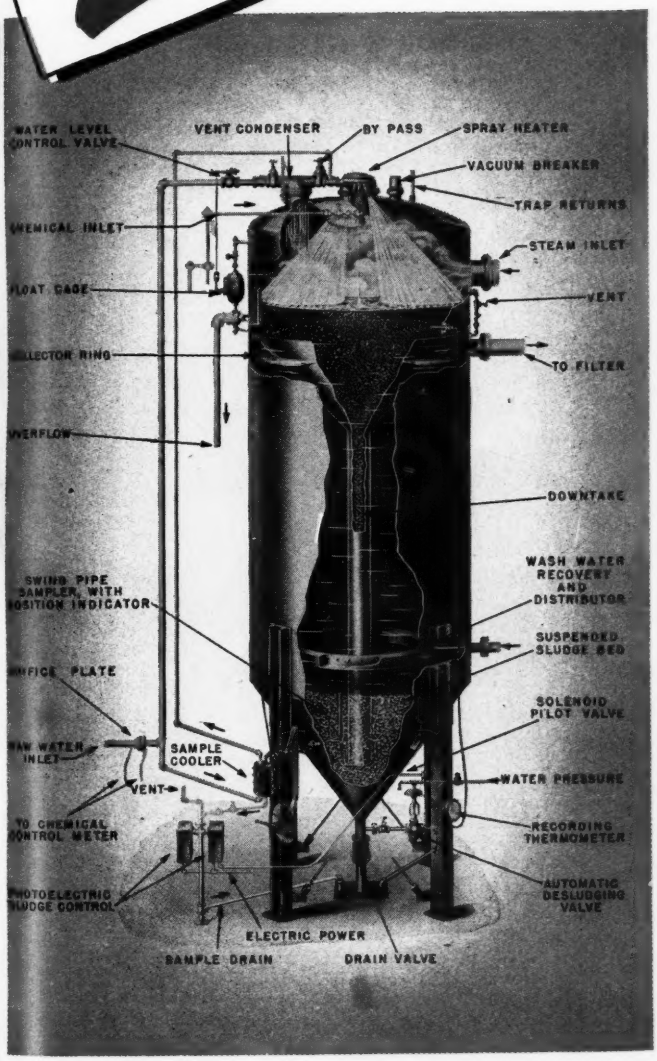
NOW, for the first time, Permutit has added to the De-mineralizing process, a new, one-step, cold process silica removal treatment which removes silica down to a fraction of 1 p.p.m.—making possible ideal, silica-free, de-mineralized boiler-feed make up!

For information about this revolutionary new, low first cost, low operating cost treatment, address The Permutit Company, Dep't PP10, 330 West 42nd Street, New York 18, N. Y., or Permutit Company of Canada, Ltd., Montreal.

WATER C
The Permutit Compan

NEW DEVELOPMENTS!

2. SLUDGE BLANKET HOT PROCESS!



GREATER ECONOMY IN CHEMICAL COST... GREATER EFFICIENCY IN REMOVAL!

The Permutit* Sludge Blanket Hot Process reduces turbidity of softened water, lessens the load on filters, reduces back-washing and lowers the amount of silica left in the water.

Low turbidity, a feature of this new Sludge Blanket design, effects considerable chemical savings because of its low consumption of expensive phosphate reagent. In addition, the new process reduces the amount of lime required, since unconsumed lime is retained in the blanket until it reacts with water hardness.

A higher degree of silica removal is possible with this new model because each particle has an intimate, prolonged contact with silica-absorbing magnesia.

The depth of the sludge bed is controlled by an automatically-operated desludging valve actuated by a photoelectric turbidity detector. This detector automatically checks a continuous water sample and maintains turbidity at the desired value.

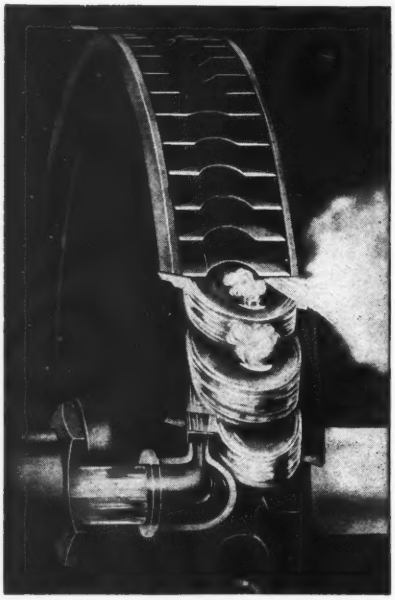
Write today for free, informative bulletin.

Trademark Reg. U. S. Pat. Of.

CONDITIONING HEADQUARTERS

330 West 42nd Street, New York 18, N. Y., or Permutit Company of Canada, Ltd., Montreal

The TERRY



Action of steam in Terry Solid Wheel Turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket, in which its direction is reversed 180°. The steam is caught in a stationary reversing chamber and returned to the wheel. This process is repeated several times.

USES A SOLID STEEL ROTOR

The rotor of the Terry Wheel Turbine is made from a single forging of special composition steel. The semi-circular buckets or pockets are milled from the solid metal. The steps in the machining of a wheel are shown below. There are no parts to become loose or work out.

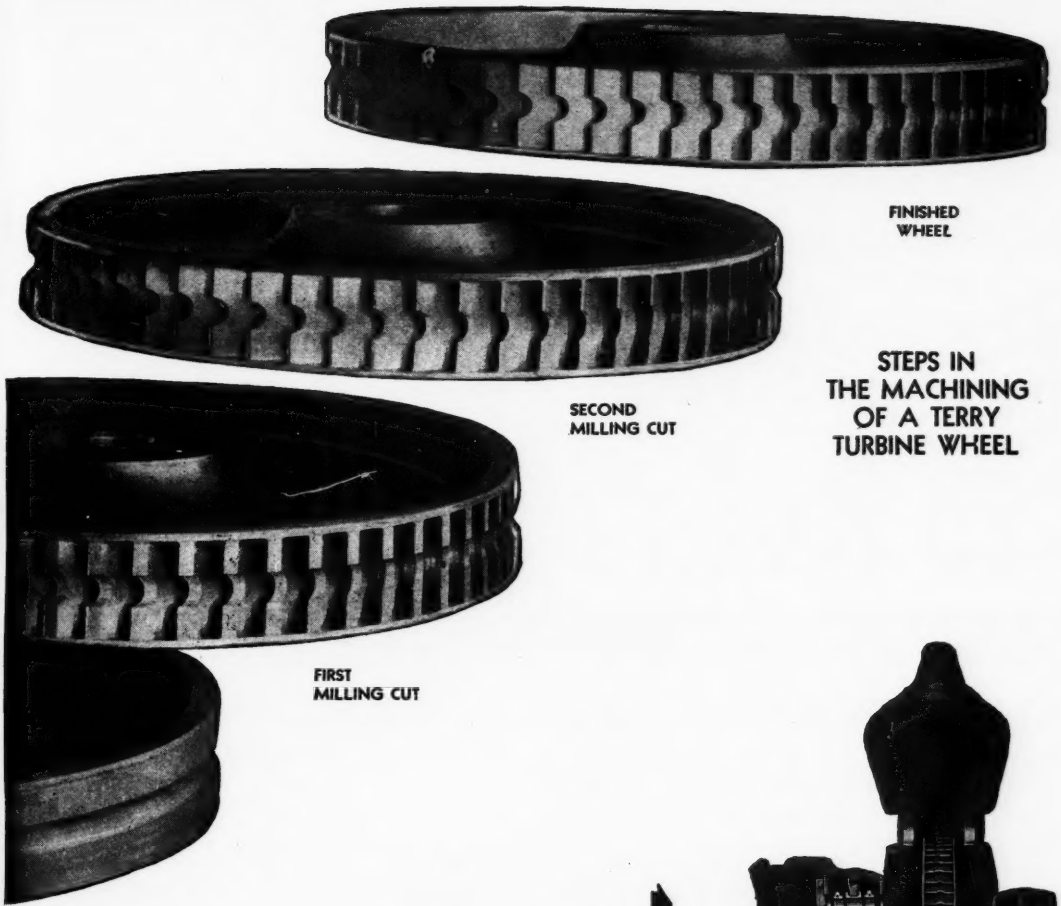
The power-producing action of the steam in the wheel buckets takes place entirely on the curved surface at the back of the bucket and therefore close blade clearance is not necessary.

As the only function of these blades is to form a series of pockets, wear of the blades is of little consequence and does not materially affect the horse power or efficiency. The important part of the bucket is the back or bottom, which is a solid forging.

FORGING — ROUGH TURNED

THE TERRY STEAM TURBINE CO.

Wheel Turbine



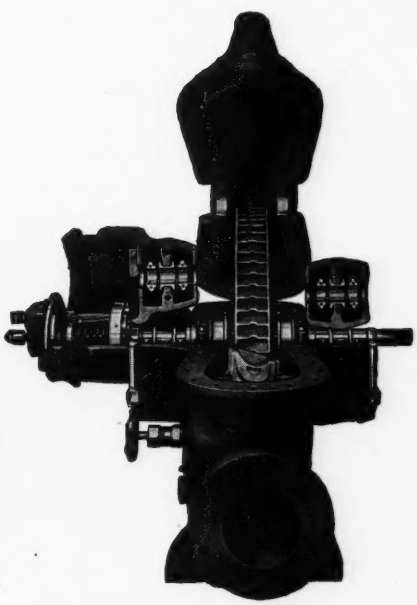
FINISHED WHEEL

SECOND MILLING CUT

FIRST MILLING CUT

SMOOTH TURNED

STEPS IN THE MACHINING OF A TERRY TURBINE WHEEL



Typical Terry Solid Wheel Turbine with cover and bearing caps raised. Note the ruggedness and the accessibility of all parts. Units of this type are used to drive boiler feed pumps, generators, and all types of power plant equipment. Built in sizes from 5 H.P. to 2000 H.P.

FOR FULL DETAILS ASK FOR BULLETIN S-116

T-1156

TERRY SQUARE - HARTFORD, CONN.

Running to Ruin

...SO THAT YOU WILL GET LONGER LIFE FROM EVERY TEXROPE V-BELT

THIS MACHINE tests TEXROPE Super-7 V-Belts — runs them at varying speed and load until they give out. A trained operator records results: How long did they last? What broke down first: Cords? Cover? Rubber compound? Does destructive heat develop?

Out of tests like this have come stronger cords—tougher, more wear-resistant covers — resilient, cooler-running rubber — vital improvements in design and construction. TEXROPE Super-7 V-Belts are today the BEST in 20 years of V-Belt experience.

A-C FOR COMPLETE V-BELT SERVICE

Call your nearest Allis-Chalmers office or dealer for ALL your V-Belt drive needs — TEXROPE Super-7 V-belts all types, all sizes; TEXSTEEL, TEXDRIVE and "Magic-Grip" Sheaves; VARI-PITCH Sheaves and SPEED CHANGERS. They're all engineered and backed by the originators of the Multiple V-Belt Drive for industry. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

A 2099

PICK YOUR SUPER-7 V-BELT

Heat-Resisting Super-7
Stands temperatures up to 180°. The TEXROPE V-Belt for most drives.

Oil-Resisting Super-7
Neoprene cover protects core against moderately oily or greasy conditions.

Oil-Proof Super-7
Made of Neoprene throughout. Use it when the belt must swim in oil.

Static-Resisting Super-7
Recommended where explosion hazard exists. Static-conducting element throughout cover won't wear off.

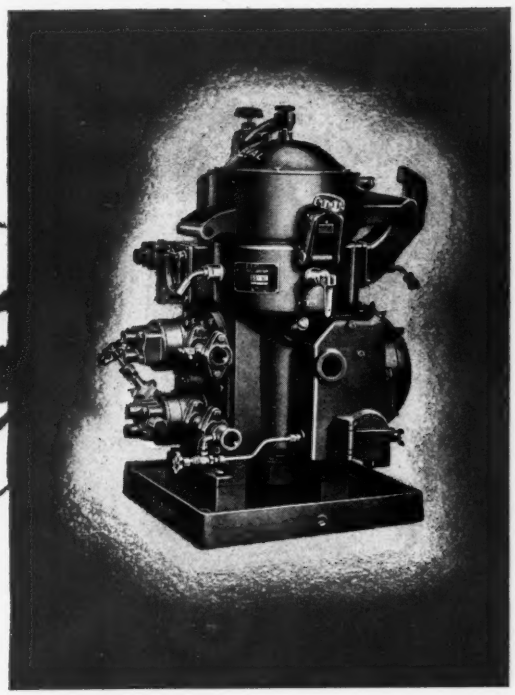
TEXROPE Super-7 V-Belts result from the co-operative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products

TEXROPE V-BELT DRIVES

GIVE YOUR TURBINE . . .



PROTECT your turbine from ***both*** of the chief causes of lubrication failure—dirt and water. To rid the lubricating oil of dirt only is to give the turbine just ***half*** of the protection it requires.

A De Laval Oil Purifier provides a simple, effective means of insuring against the troubles caused by water and dirt. Its purifying action is instantaneous and wholly mechanical. Foreign material is thrown out by centrifugal force, and this centrifugal force removes from the oil and continuously discharges condensate or other water.

If a turbine protected by a De Laval Oil Purifier should develop a water leak, the excess of water would likewise be removed before damage could be done. There would be no sudden formation of "liver" in the lubrication system.

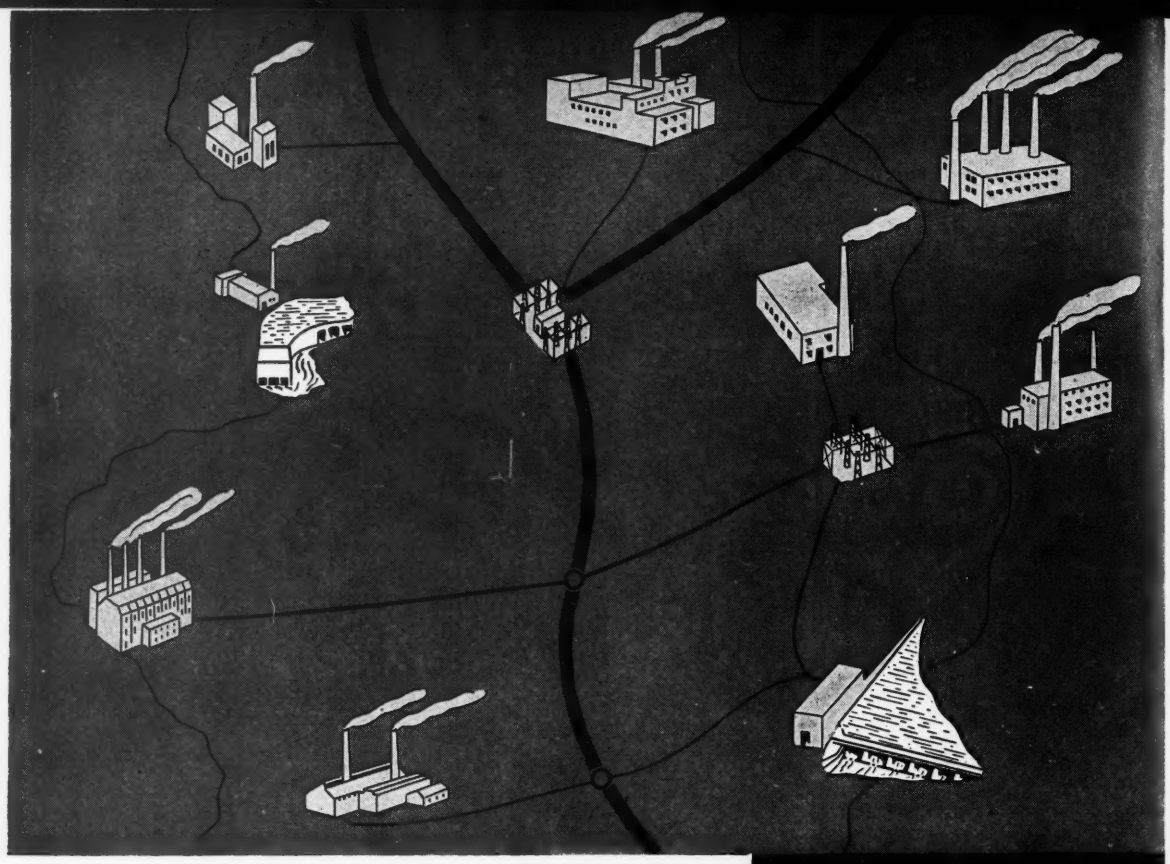
De Laval Oil Purifiers have another inherent advantage—they discharge the purified oil with oil-soluble additives intact.

- Write for Bulletin 400 for details.

DE LAVAL

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER

LUBRICATING OIL PURIFIERS



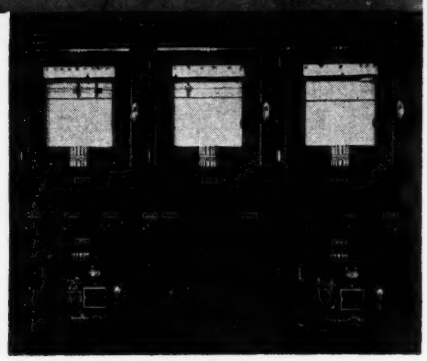
REALIZATION of a System's Potential Economy is largely in The Dispatcher's Hands

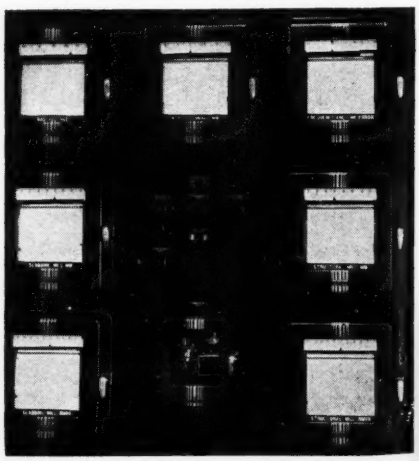
The system economy which a load dispatcher customarily maintains—and which is his regular responsibility—can be increased very substantially by giving him two automatic "tools" for his work.

One tool is a Micromax Load Recorder or Recorders to show load conditions promptly and continuously. The other tool is L&N Automatic Load-Frequency Control, to carry out the dispatcher's orders.

Approximately 1/100 of 1 per cent—or the order of twenty-five hundred dollars out of 25 million—of the total capital invested in a power system, will give its dispatchers this equipment. The installation is even more advisable when one recalls that the dispatchers are largely responsible for operation of the major equipment which represents a big share of the total investment.

This is just one reason why systems totaling more than 35,000,000 kw capacity now use these L&N instruments. At your request, an L&N engineer will be glad to sit down with you and explain, or to send Technical Publication N-56-161(1), as you may prefer.





L&N Load Recording and Load-Frequency Controlling Panels. Above—for a Public Utility; below—for a Steel Mill.

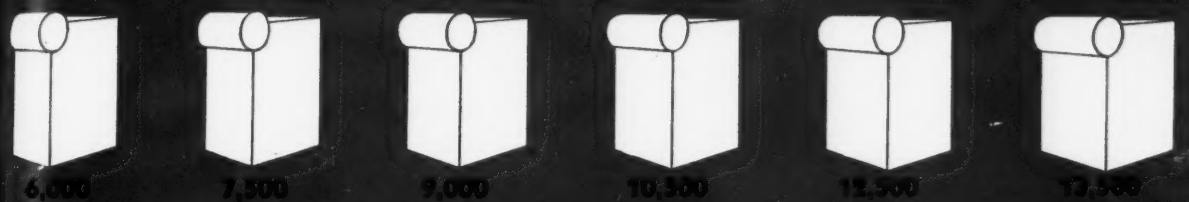
LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

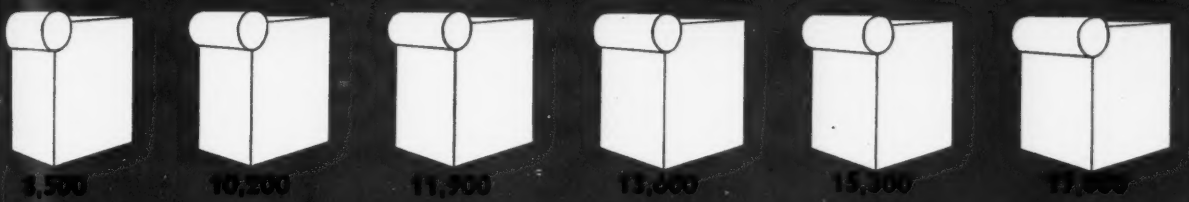
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Standardized!

. . . to save you time and money



pounds of steam per hour (10 ft. tubes)



pounds of steam per hour (12 ft. tubes)

type "m"

● Springfield's new standardized line of Type M boilers makes it easy to meet small to medium size steam plant needs with minimum delay and less capital investment. Designed for high efficiency, automatic firing with oil or gas, Type M boilers incorporate numerous outstanding quality features: water-cooled furnace . . . electric cast steel headers . . . welded, x-rayed, stress-relieved drum . . . water-cooled sectional baffles. All dimensions are standardized — width varies with capacity. Twelve sizes to choose from All facts and figures available. Ask for complete information.

SPRINGFIELD BOILER CO.
1951 E. Capitol Ave., Springfield, Ill., U. S. A.

ask for a copy...

New Bulletin No. 746 just off the press!

SPRINGFIELD

STEAM GENERATING UNITS

SPRINGFIELD BOILERS

ANY SIZE
ANY FUEL
ANY PRESSURE

B. t. u. Savers

FLOW METERS

Electrical Remote Reading Type

Republic electrical type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 10,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type.

WRITE FOR DATA BOOK No. 701

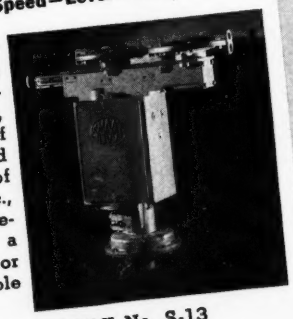
RECORDING THERMOMETERS

Republic thermometers are available for recording temperature of flue gas, temperatures in vats or tanks either open or closed and under pressure. For unusual conditions, special bulbs are furnished of corrosion resisting metal or with a protective coating.

WRITE FOR DATA BOOK No. 210

REGULATORS

Pressure—Flow—Speed—Level—Ratio



Republic hydraulic or pneumatic type regulators are supplied for the automatic control of pressure, rate of flow, speed of rotation, level of a liquid or the proportioning of two pressures, flows, etc., in a fixed ratio by mechanically operating a valve, damper, rheostat or various types of variable speed transmissions.

WRITE FOR DATA BOOK No. S-13

PNEUMATIC TRANSMITTERS

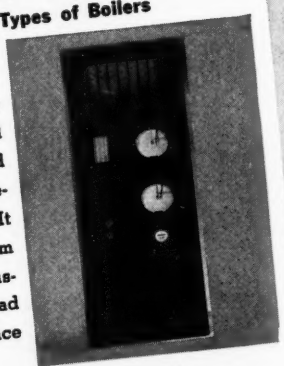
Operating On The Force-Balance Principle

Republic pneumatic transmitters are devices for converting process variables, such as flow, liquid level, pressure or liquid density, into air pressures which vary proportionally with the process variables. These air pressures can be used as the measuring impulse for the actuation of an automatic controller or a direct reading recorder.

WRITE FOR DATA BOOK No. 1000

COMBUSTION CONTROL

For All Sizes and Types of Boilers

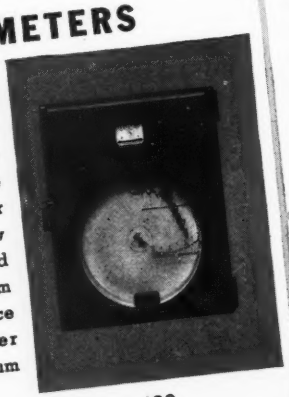


Republic automatic combustion control is available for all sizes of boilers, all types of fuel firing, all load conditions and any arrangement of draft equipment. It maintains constant steam pressure, highest combustion efficiency, desired load division, constant furnace draft.

WRITE FOR DATA BOOK No. S-21

BOILER METERS

Record Steam Flow-Air Flow



The Republic Boiler Meter records simultaneously on one chart the steam flow from the boiler and the rate of air flow to the furnace for combustion. The air flow pen is adjusted to record coincident with the steam flow pen when the furnace is receiving the proper amount of air for maximum combustion efficiency.

WRITE FOR BULLETIN No. 420

DRAFT AND PRESSURE INSTRUMENTS

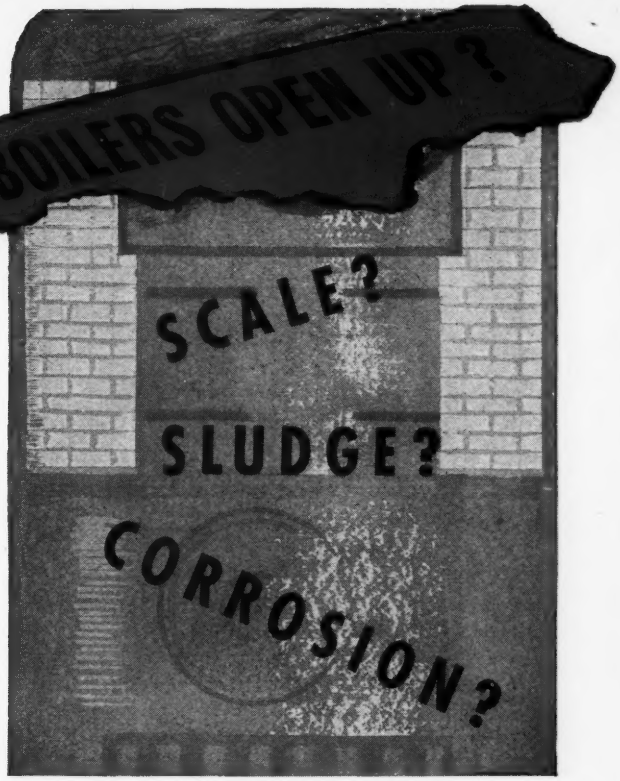
For indicating and recording drafts, pressures and differentials, Republic dry-bellows type indicators and recorders are supplied for all ranges encountered in furnace operation, in any desired combination.

WRITE FOR BULLETIN No. 802.

Republic Flow Meters Co.

2240 Diversey Parkway — Chicago, 47, Illinois

HOW WILL YOUR BOILERS OPEN UP?



Will you find...

NOT IF YOU'RE USING **AMEROID**

THE COMPLETE BOILER WATER TREATMENT

AMEROID

THE COMPLETE BOILER WATER TREATMENT

WHAT IS IT?

1. Sound chemical treatment. 2. A good organic coagulant. 3. Simple, scientific control. 4. Competent service and instruction.

WHAT WILL IT DO FOR YOU?

1. Prevent scale and corrosion. 2. Eliminate carry-over. 3. Regulate blowdown to save fuel. 4. Stop costly over-dosing, harmful under-treatment.

Engineers who use AMEROID Boiler Water Treatment know from day to day that their boilers are operating with maximum efficiency and economy. They are assured a clean bill of health at every boiler opening.

E. F. DREW & CO., INC.

15 EAST 26th STREET, NEW YORK 10, N. Y.

COMPLETE AMEROID SERVICE is available in key cities of the United States, Canada, Mexico, Brazil and Puerto Rico.

AMEROID

THE COMPLETE BOILER WATER TREATMENT

E. F. DREW & CO., INC.
15 East 26th Street. New York 10, N. Y.

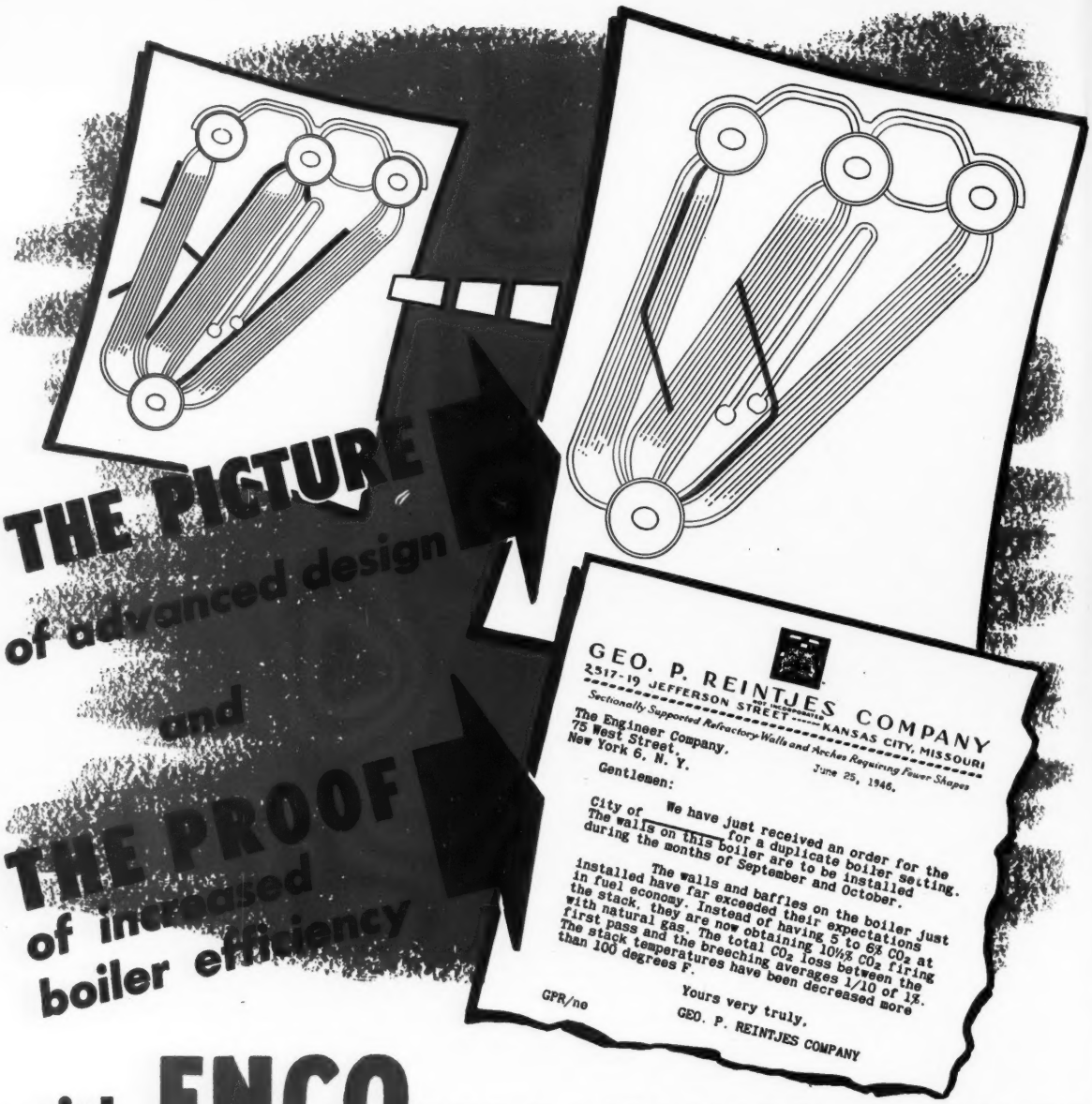
I am interested in further information about AMEROID, the Complete Boiler Water Treatment.

NAME .....

FIRM .....

ADDRESS 76

MAIL THIS COUPON TODAY!


THE PICTURE
of advanced design
and
THE PROOF
of increased
boiler efficiency
GEO. P. REINTJES COMPANY
2317-19 JEFFERSON STREET KANSAS CITY, MISSOURI
Sectionally Supported Refractory Walls and Arches Requiring Fewer Shapes
The Engineer Company,
75 West Street,
New York 6, N. Y.
June 25, 1946.
Gentlemen:
We have just received an order for the City of for a duplicate boiler setting.
The walls on this boiler are to be installed during the months of September and October.
The walls and baffles on the boiler just installed have far exceeded their expectations in fuel economy. Instead of having 5 to 6% CO2 at the stack, they are now obtaining 10½% CO2 firing with natural gas. The total CO2 loss between the first pass and the breeching averages 1/10 of 1%. The stack temperatures have been decreased more than 100 degrees F.
Yours very truly,
GEO. P. REINTJES COMPANY
GPR/ne

with ENCO STREAMLINED BAFFLES

Study these diagrams for just a moment. Notice how the improved baffle design assures a uniform, high velocity gas flow over every square foot of heating surface. Enco Streamlined Baffles are smoothly curved to maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and soot pockets are eliminated. The result: reduced draft losses and maintenance costs—increased operating efficiency.

Enco Streamlined Baffles are engineered to the exact requirements of your boiler and installed by experienced Enco-trained crews. The 18 page Enco Bulletin, BW-44, fully describes the profit-proved advantages of Enco Streamlined Baffles and their adaptability to every type of Water-tube Boiler. Call or write for your free copy today!

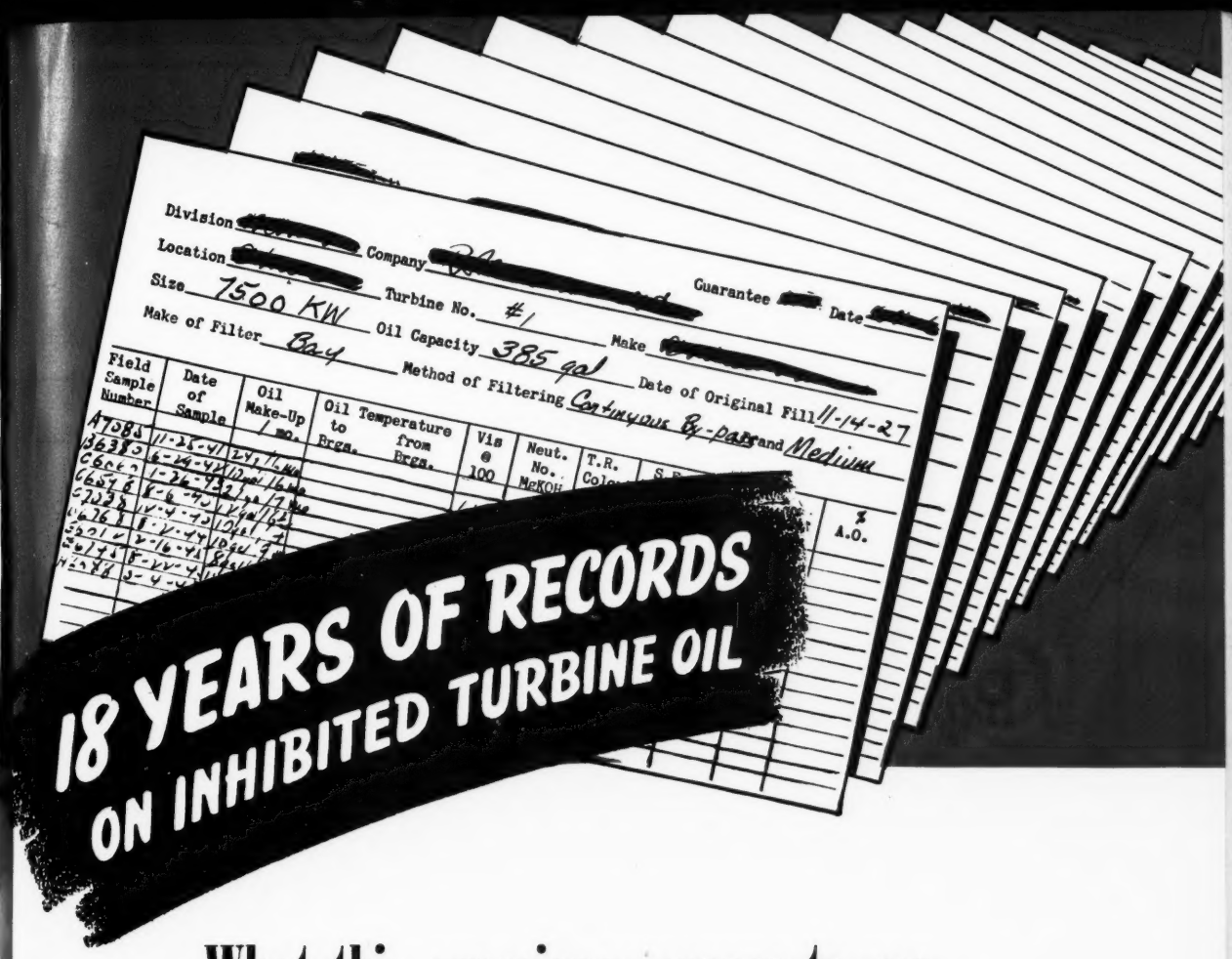
The Engineer Company produces:

- Enco Streamline Baffles
- Enco Oil Burners
- Enco Fuel Oil Pumping and Heating Units
- Enco Automatic Oil-Electric Ignition System
- Enco Automatic Combustion Control

THE ENGINEER COMPANY
75 West Street
New York 6, New York

Canadian Representative:
F. J. Raskin, Ltd., 370 Rachel E., Montreal, P. Q.

EC-465



What this experience means to you...

Since the first fill of oxidation-inhibited, guaranteed Nonpareil Turbine Oil was installed 18 years ago, records have been kept of its operation in every installation made. Oil samples are checked periodically at Standard Oil Laboratories for acidity, demulsibility, viscosity and other significant qualities. Few, if any, oils have as long or complete a record of their performance in service as is available on Nonpareil.

To users of Nonpareil these records give complete assurance that the oil in a turbine is living up to its guarantee not to increase in acidity and that demulsibility and contaminants in the oil are well within safe limits. To prospective users of Nonpareil these records show that Nonpareil has met all requirements, regardless of the changes and improvements in turbine design, over the years.

In addition, if you are interested in an oxidation-inhibited oil, a Standard Oil Lubrication Engineer can give you all the facts based on 18 years of recorded experience with hundreds of installations to prove that oxidation-inhibited Nonpareil Turbine Oil will eliminate excessive acidity formation, reduce sludge and deposits to the point where Nonpareil will never require replacement or even removal for treating. Standard Oil Company (Indiana), 910 South Michigan Ave., Chicago 80, Ill.

NONPAREIL
TURBINE OIL

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

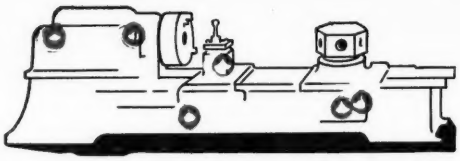
CODED LUBRICATION

tells your oilers 4 important facts... with simple numbers

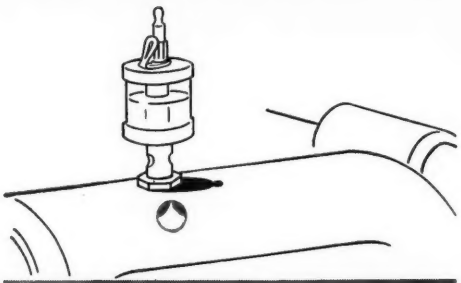
TROUBLED with getting the right lubricants in the right places? Standard's Coded Lubrication Service can help you. And it's easy to install and simple to follow.

Code numbers, not colors, are assigned to each lubricant used in your plant. Numbered decals are applied at each point to be lubricated, indicating which lubricant is to be applied. Every grease gun, oil can and storage container is numbered to indicate what lubricants are in them. Your oilers simply follow the numbers without having to remember brand names and grades.

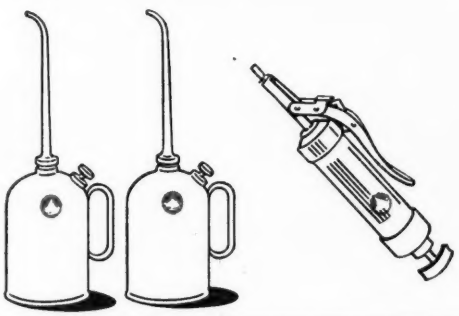
A Standard Oil Lubrication Engineer will be glad to discuss the application of Coded Lubrication in your plant. Call the nearest local Standard Oil office or write 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.



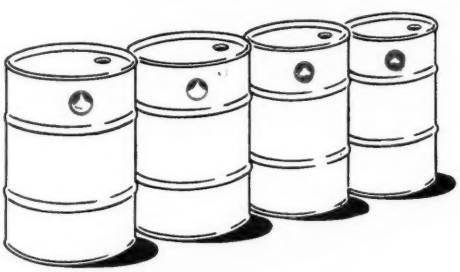
1. Where lubricant is needed



2. Which lubricant to use



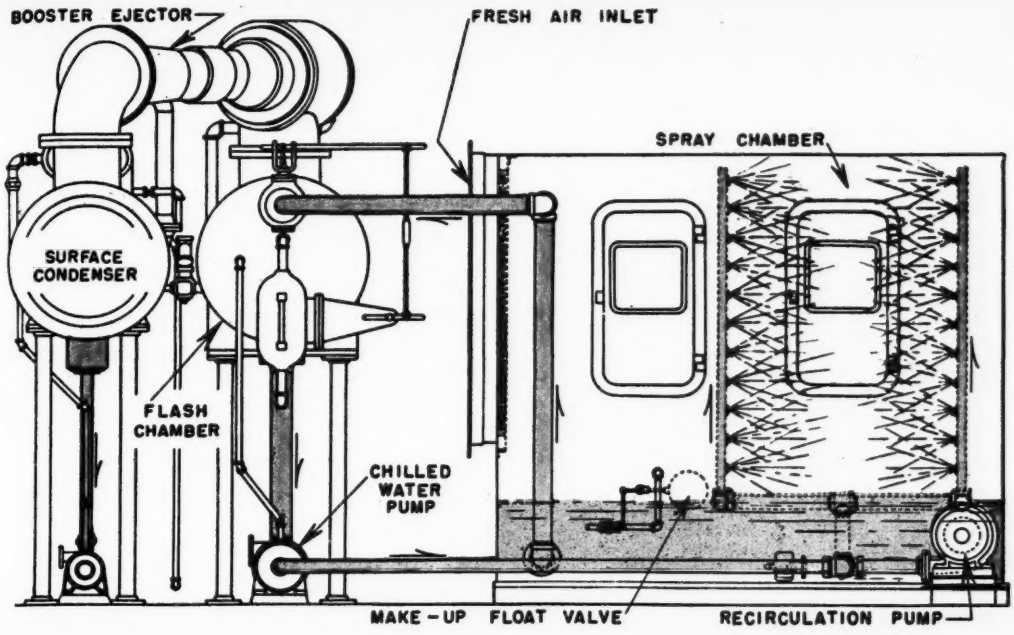
3. Which oil can or grease gun to use



4. Which lubricant is in each storage container

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE



VACUUM REFRIGERATION *for Air Conditioning*

Vacuum refrigeration supplies cold water for conditioning air in industrial plants, which increases production, enables management to realize actual dollar savings.

Vacuum refrigeration systems cool water by subjecting it to high vacuum. This high vacuum is created by steam jet air ejectors which flash a small percent of the warm supply water, remove it as vapor, thereby cooling the remaining water to temperatures as low as 40 deg. F. Cool clean water, the refrigerant used by Foster Wheeler vacuum refrigeration is the safest and cheapest coolant for the modern plant.

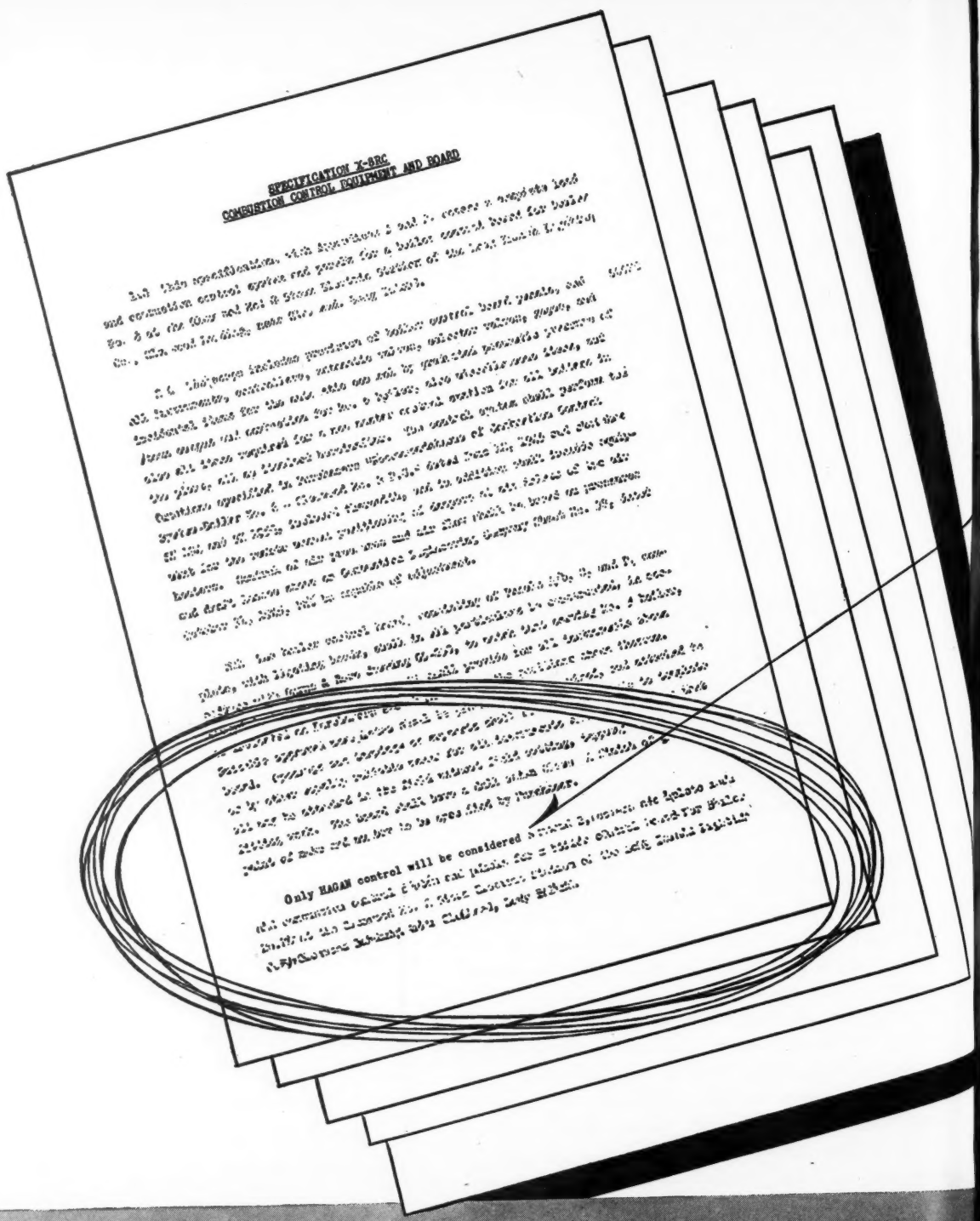
FW booster ejectors, designed for water cooling, evacuate the flash chamber with complete economy and efficiency.

Information about applications of vacuum refrigeration from any branch office, or address 165 Broadway, New York 6, N. Y.

VACUUM REFRIGERATION

- low initial cost
- low maintenance cost
- licensed or skilled operators unnecessary
- no toxic, explosive refrigerants
- no moving parts
- fits into limited or low headroom space

FOSTER WHEELER



HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

HAGAN control will be considered"

Specifications for an automatic combustion control system for a small steam plant in a Southern state, which came to us a short time ago, included this sentence—"Only Hagan Control will be considered."

As far as we could learn, the purchaser had no previous experience with Hagan Automatic Combustion Control, so we set out to learn the reason for the confidence implied by that flat statement.

It was due, we discovered, to the representative of the stoker manufacturer! His observation of hundreds of plants in which his company's stokers were installed had shown him that fuel consumption was lower when Hagan Control was used.

Naturally he wanted his stokers to give the best possible performance, so he had formed the habit of recommending Hagan Control whenever opportunity offered.

He had found that Hagan gave excellent results in small plants as well as large, for the Hagan equipment in all plants meets exactly the same standards of design and construction. The lower cost of the small plant systems is achieved by simplifying the system, eliminating refinements that are not required for adequate regulation of smaller boilers.

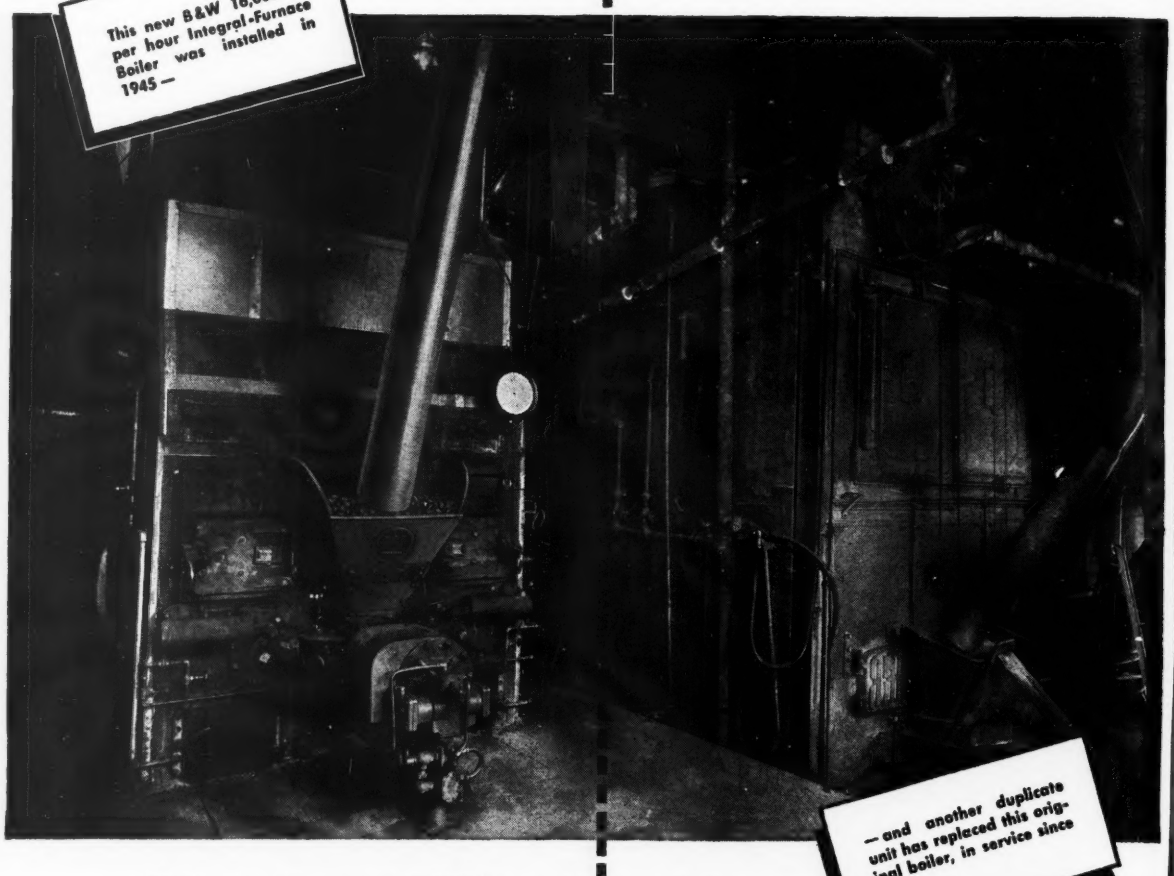
This simplification is facilitated by the fact that all Hagan Automatic Combustion Control systems are based on the principle that *control* and *metering* are separate functions. With Hagan control, combustion conditions are set up by the control system; meters merely show what is happening.

If you want more efficient boiler operation and lower fuel consumption, arrange to have a Hagan engineer visit your plant. He will be glad to survey it and make recommendations, without any obligation on your part.

HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN
HALL
BUROMIN
CALGON

44 YEARS' PERFORMANCE


This new B&W 16,000 lb. per hour Integral-Furnace Boiler was installed in 1945—
—and another duplicate unit has replaced this original boiler, in service since 1901.

Distinctive Features of B&W Integral-Furnace Boilers that Assure Faithful Performance:

1. Water-cooled furnace sidewalls and roof are of the same durable stud-tube construction used in large central-station boilers.
2. Deep furnace, fired from one end, provides ample space for complete combustion.
3. Bare metal blocks cover and protect the tubes of the water-cooled furnace floor, provide a surface readily cleared of ash.
4. Self-draining superheater design prevents accumulation of water in the tubes, and a stud-tube wall shields the second and third banks from direct furnace radiation.
5. Tubes of the third bank, which is in the zone of coolest gases, act as down-comers, insuring rapid, positive circulation at all loads.

SELLS SATISFIED USER

TWO *MORE* B&W's

Again it's the story of "satisfied customer comes back for more" . . . a story that has been an old one with B&W for many years.

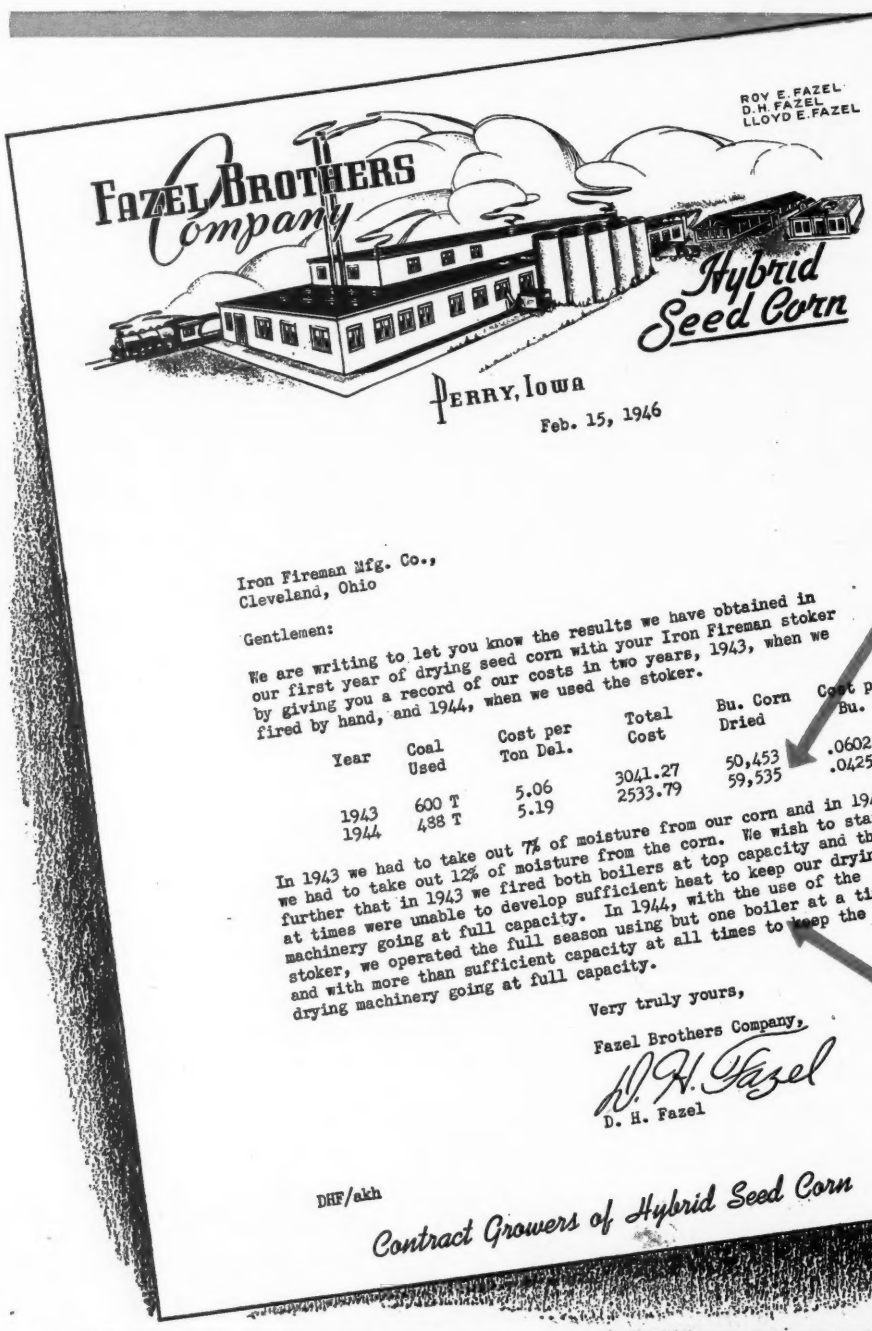
Old, too, were the boilers the story's about—two B&W longitudinal-drum boilers purchased by The Lunkenheimer Company of Cincinnati back in 1901—and still in daily operation at the time they were removed for plant expansion only last year.

In testimony to the performance of these veterans, the two new units that replace them also bear the B&W name. They are modern B&W Integral-Furnace Boilers, a type that has won sweeping acceptance in almost every major industry for high availability and continuity of service . . . for rapid response to fluctuations in load demands . . . for the production of clean, dry steam . . . for over-all economy with all types of fuel.

G-322-T

B&W
BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: ALLIANCE AND BARBERTON, O.; AUGUSTA, GA.

How do IRON FIREMAN


ROY E. FAZEL
D.H. FAZEL
LLOYD E. FAZEL
FAZEL BROTHERS Company
Hybrid Seed Corn
PERRY, IOWA
Feb. 15, 1946
Iron Fireman Mfg. Co.,
Cleveland, Ohio
Gentlemen:
We are writing to let you know the results we have obtained in our first year of drying seed corn with your Iron Fireman stoker by giving you a record of our costs in two years, 1943, when we fired by hand, and 1944, when we used the stoker.
Year | Coal Used | Cost per Ton Del. | Total Cost | Bu. Corn Dried | Cost per Bu.
1943 | 600 T | 5.06 | 3041.27 | 50,453 | .0602
1944 | 488 T | 5.19 | 2533.79 | 59,535 | .0425
In 1943 we had to take out 7% of moisture from our corn and in 1944 we had to take out 12% of moisture from the corn. We wish to state further that in 1943 we fired both boilers at top capacity and then at times were unable to develop sufficient heat to keep our drying machinery going at full capacity. In 1944, with the use of the stoker, we operated the full season using but one boiler at a time and with more than sufficient capacity at all times to keep the drying machinery going at full capacity.
Very truly yours,
Fazel Brothers Company,
D. H. Fazel
DHF/akh
Contract Growers of Hybrid Seed Corn

Production up 8½%

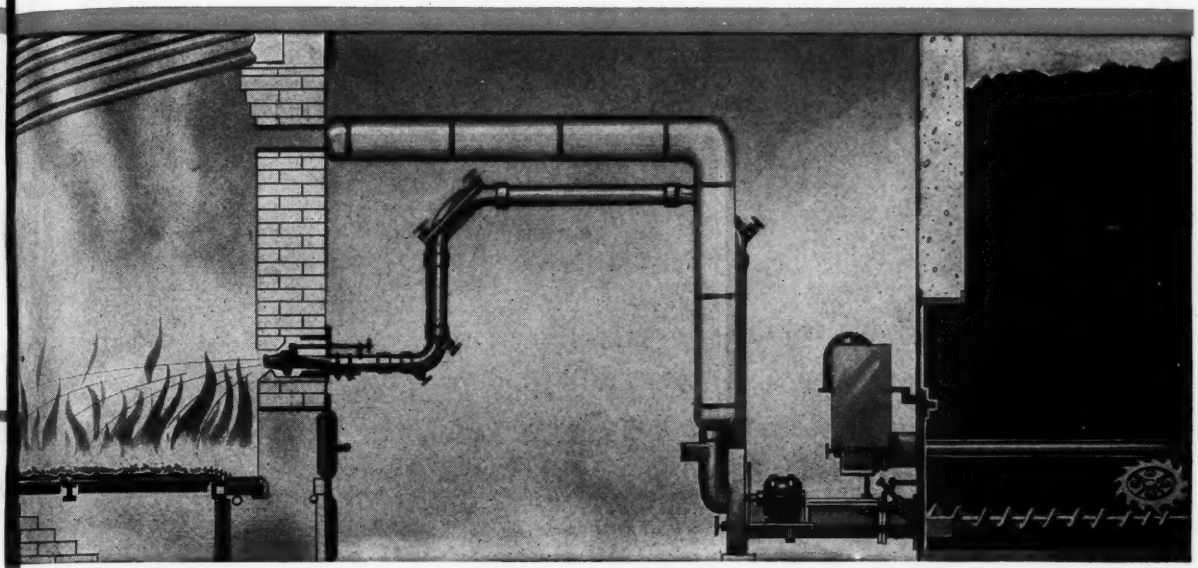
Fuel Cost down 29¼%

One boiler does the work of two

HEAVY DUTY AUTOMATIC COAL STOKER

IRON FIREMAN

NSTOKERS get these results?



The Iron Fireman Pneumatic Spreader Stoker meters steam size coal from hopper or main coal bunker to transfer housing, where coal is picked up by a pneumatic conveyor and delivered to the furnace. The conveyor nozzle accurately spreads the larger particles of coal over the entire grate in a shallow, uniform fuel bed. The preheated fines burn in suspension, reducing the cinder carry-over and greatly improving the combustion efficiency and responsiveness, as compared with other stokers which do not preheat fuel.

Gets more heat from lower cost coal

The Iron Fireman Pneumatic Spreader stoker not only saves tonnage by more efficient combustion but cuts the cost per ton by using lower cost stoker coal. This scientifically controlled rate of burning enables Iron Fireman to efficiently burn the small size and low ash fusion coals as well as sub-bituminous and lignite. Complete burning gives more heat to answer fluctuating load demands.

Automatic controls eliminate wasteful firing

The positive control of fuel and air supply is the key to Iron Fireman efficiency. Adjusting the rate of fuel feed and the distribution of undergrate air to maintain the requisite steam supply, Iron Fireman regulated firing virtually eliminates smoke and clinkers which mark wasteful firing. Throughout the entire firing cycle the same high combustion efficiency is maintained by sensitive, positive control of all factors of combustion.

Dependable and flexible in operation

Rugged in construction yet delicate in operation Iron Fireman's dependability is reflected in 23 years of providing complete heating satisfaction. Highly responsive to widely changing steam demands Iron Fireman Pneumatic Spreader stoker gives a flexibility of operation to meet any boiler room need. Installation, made by trained Iron Fireman engineers, will be designed to fit your particular heating system.

What about YOUR boiler room?

A survey in your plant made without cost or obligation to you, will show what Iron Fireman stokers will accomplish in your boiler room. Take advantage of the high combustion efficiency, the utilization of low-cost fuel, low labor costs, and minimum maintenance costs which Iron Fireman offers. For such a survey or literature address Iron Fireman Manufacturing Company, 3052 West 106th Street, Cleveland, Ohio. Other plants in Portland, Oregon; Toronto, Canada.

FIREMAN

FOR POWER PROCESSING AND HEATING

Scovill Tube News

Vol. 4 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 3

Fresh vs. Salt Water

Effects on Condenser and Heat Exchanger Tubes

It is generally well known that condenser tubes in an installation using fresh, natural cooling waters will have normally a longer life than tubes in a similar installation in contact with salt or brackish water. It has also been observed that in a fresh water installation in which tube life has been 20 years or longer, replacement tubes in the same unit may fail after a shorter period. Many times, periodic water analyses will give some clue as to the cause of the drastic change. In some cases, although it is known that contamination of the water supply has been responsible for failures (as for example, by pollution or the presence of suspended solids, etc.), the seriousness of this condition is not always reflected in a water analysis.

FRESH WATER

In any given water there are certain components which are much more detrimental to the life of condenser tubes than others. Also the corrosion of tubes may not be a direct chemical attack of the particular compound but may be a secondary reaction resulting from the deposition of salts of that constituent.

Carbonates

Water with 350 ppm of Bicarbonates would not be considered as corrosive to brass condenser tubes. However, the chief trouble with water of this type is the heavy scaling of tubes resulting from the precipitation of carbonates from the water onto the tube surfaces. Due to this reaction, pitting might be encountered as a result of concentration cell action and relatively severe dezincification of certain brasses might take place under some particular conditions of service. Fortunately, water treatments may be used to prevent deposition of calcium carbonate. Also Phosphorized Admiralty can be installed if dezincification is a problem.

ph Value

The acid properties of solutions are due entirely to hydrogen ions and the determination of the ph of a solution, together with knowledge of other factors and service conditions, is helpful in the correct interpretation of the problem. Natural water having a ph of 4.0 or less would be considered dangerously acid; this condition might be caused by contamination from chemical or manufacturing plant wastes or from acid drainage from coal mines into streams. Serious corrosion of tubes may result, depending on the acid concentration and the presence of oxidizing agents such as ferric sulphate. Acid waters bring about a relatively rapid uniform thinning of tubes under certain conditions; by proper water treatment, attack of this kind usually can be minimized.

Carbon Dioxide

Relatively high concentrations of free CO_2 in water react as an acid (carbonic acid) and thereby accelerate corrosion of condenser tube material resulting in a general thinning of the tube wall. In the presence of dissolved oxygen this action is accelerated. Chemical treatment of such waters can minimize this action.

Chlorine

Chlorine dissolves in water with the formation of hydrochloric and hypochlorous acids which are very corrosive. Fortunately, chlorine is not normally found in natural water and, in the amounts usually added for the control of bacteria and algae, it has no appreciable effect on corrosion.

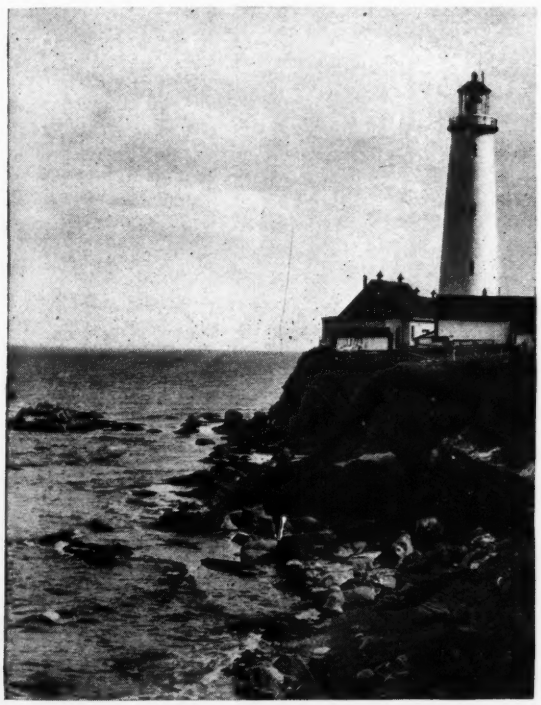
Hydrogen Sulphide

Hydrogen sulphide is a very active corroding agent and being an acid attacks most metals. Oil refinery and industrial wastes, sewage, and peaty soils are responsible for high concentrations of hydrogen sulphide sometimes found in water supplies. When in high concentrations, severe pitting of the tube surface results.

As a general rule, corrosion of copper-base alloys is not serious in contact with fresh water since the choice of the proper alloy and treatment of water can be controlled to keep attack to a minimum. An increase in the rate of attack, when attributed to changes in the water, is usually associated with a radical change in one of the above components. If such change can not be controlled by water treatment, shorter tube life results.

SALT WATER

Salt water, which normally contains about 30,000 ppm of chlorides or approximately 3% sodium chloride and minor amounts of potassium and magnesium chlorides and sulphates, is not in itself a serious corroding agent of copper-base alloy condenser tubes. The shorter life of condenser tubes which may be experienced in salt water installations, however, is due to appreciable amounts of trash, wastes and other substances. Depending on the location, the season of



the year, the depth of water at the intake, and other factors, these substances may or may not accelerate corrosion measurably. Compounds such as carbon dioxide, hydrogen sulphide and ammonia may occur only seasonally in harmful amounts.

Concentration Cell Action

It is known that carbon dioxide and hydrogen sulphide in sea water may produce a non-protective deposit over the metal surface which would promote the formation of concentration cells and result in intense localized pitting. Since the electrical conductivity of salt water is very much higher than fresh water, due to the ionization of the salts in solution, the attack resulting from concentration cell action would be much more severe than in fresh water. Concentration cell action is electro-chemical in character and is due to potential differences between adjacent surface areas where a difference exists in the concentration of salts, ions or gases.

The rate of attack resulting from compounds that cause trouble in fresh water is measurably increased in salt water, due to the greater concentration of ions and the resultant higher conductivity. Control of these compounds in salt water is very difficult. Also, in salt water it is not unusual to have hydrogen sulphide, ammonia, and carbon dioxide present simultaneously.

Any electro-chemical type of corrosion such as dezincification, galvanic action, and concentration cell action is much more severe in salt than in fresh water. This action alone helps to explain why salt water installations may have measurably shorter life than similar fresh water installations. In this same respect, types of corrosion common to both salt and fresh water such as erosion-corrosion and deposit attack are more severe in salt than in fresh water.

Three Scovill Services

Service in Manuals, of which "Scovill Tube News" is a sample, consists of literature providing the latest, most authentic information* on condenser and heat exchanger tubes, which has its source in the broad experience of our engineers and the findings of our laboratories. *Service in Men* offers specialized consultation on individual tube application problems and suggestions regarding alloy selection and tube installation practice. *Service in Metals* includes the development and production of a wide range of tube alloys under laboratory control, which verifies that Scovill alloys conform to specifications.

*For a free copy of the Condenser Tube Booklet, address Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Conn.

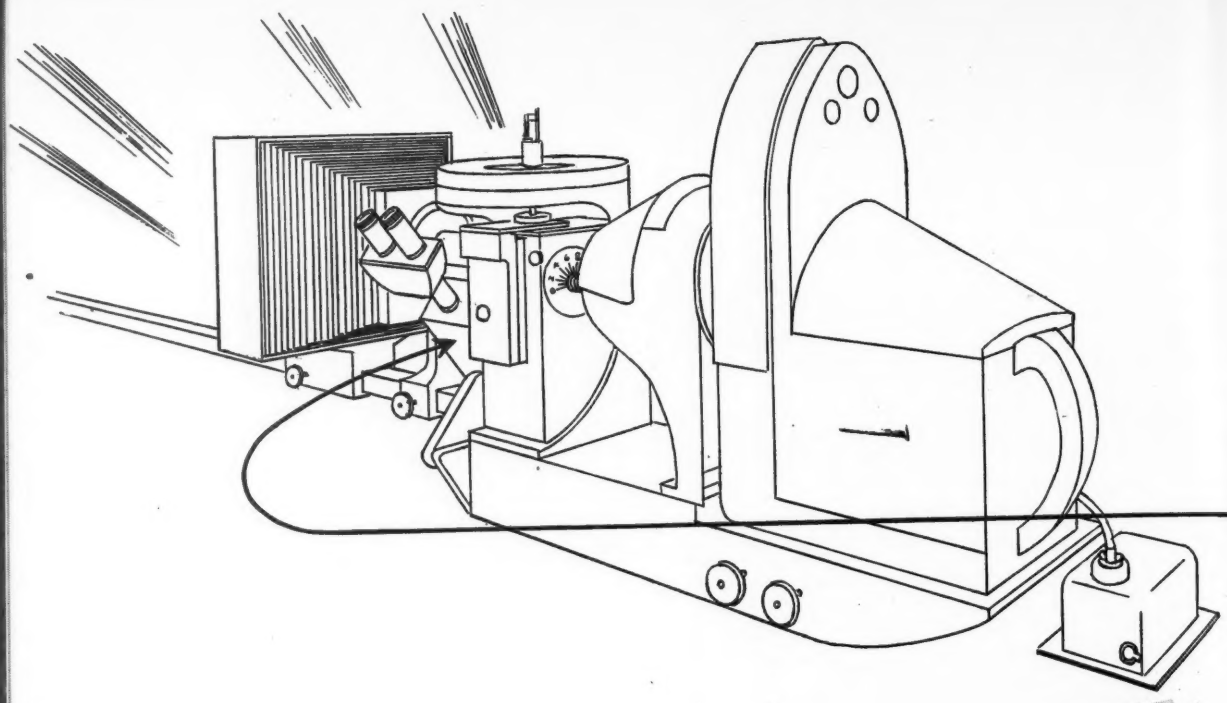
This is Number Nineteen in a series of Scovill advertisements to help you get longer life from condenser and heat exchanger tubes.

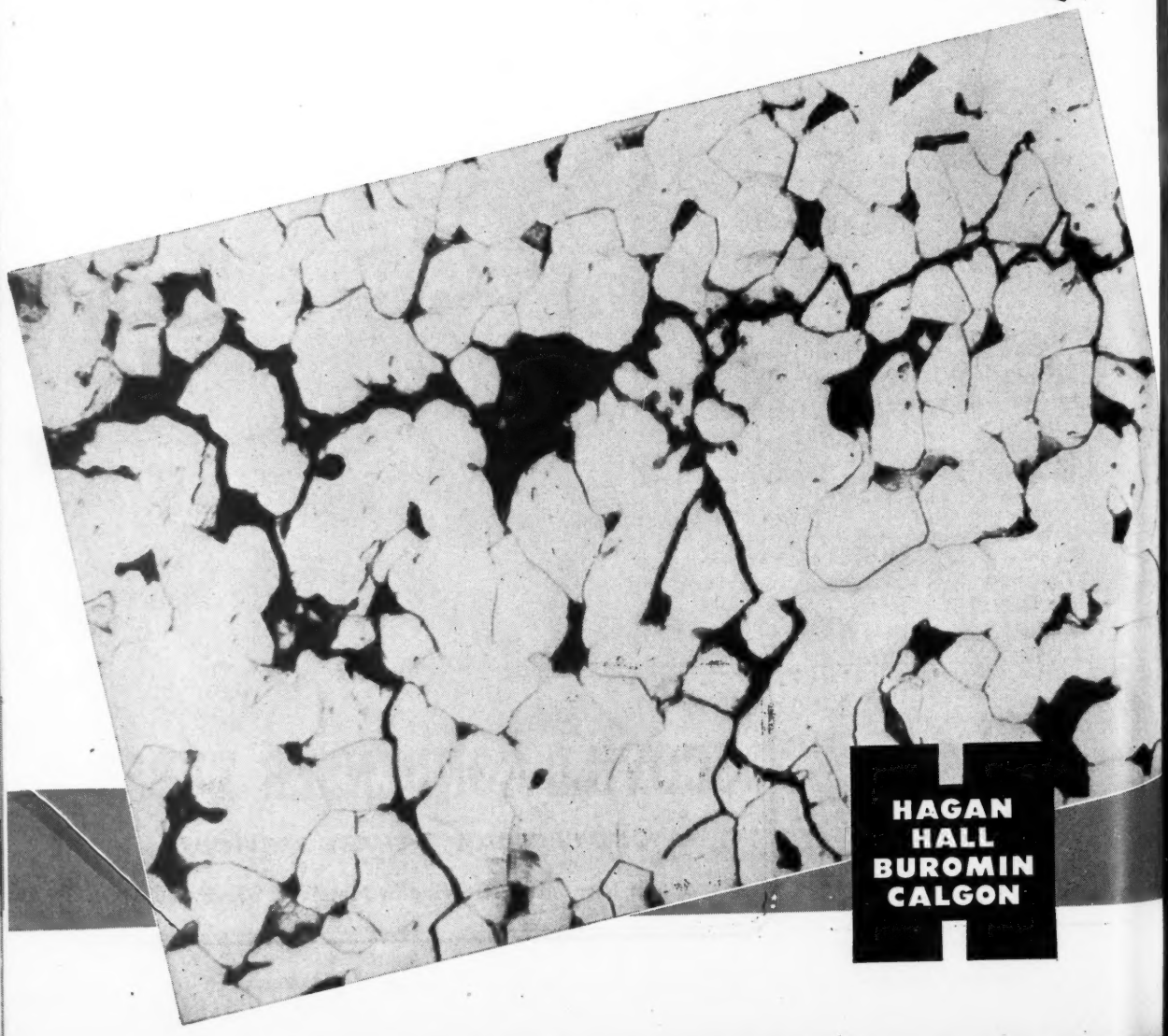
SCOVILL

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men





HAGAN
HALL
BUROMIN
CALGON

Embrittlement?

Metallographic examination gave the answer

In a Colorado plant, operating two 250 hp. longitudinal drum boilers at 120 pounds pressure, tubes frequently cracked circumferentially where the tubes were rolled into the tube sheet.

During some periods boiler outages occurred as frequently as once a week, and as many as three tubes had to be replaced each time—a costly nuisance.

A Hall service engineer was called in for consultation and a survey of prevailing water conditions was made. Also a section of a cracked tube was sent to Hall Laboratories for examination.

Not wishing to jump to conclusions Hall engineers proceeded with metallographic examination. If the cracks were due to corrosion fatigue, the fracture would be trans-crystalline in nature. The photomicrographs, however, showed a number of fine cracks which were definitely intergranular in character—evidence of caustic embrittlement.

Once the cause of the cracking was determined, the remedy was simple. On the basis of results of an embrittlement testing program conducted for several years on operating boilers in more than 300 plants, Hall Laboratories recommended the addition of sodium nitrate to the boiler water. Since the use of this embrittlement inhibitor was started, more than six months ago, there have been *no* tube failures.

The objective of Hall Laboratories and Hall service engineers is to *prevent* boiler trouble. When trouble *does* occur, the knowledge gained through long experience and constant research enables them to trace the trouble to its source and correct it.

Every plant that generates its own steam can profitably use Hall Service. We will be glad to send you full information.

HALL LABORATORIES, INC., HAGAN BLDG., PITTSBURGH 30, PA.
(A subsidiary of Hagan Corporation)

HALL SYSTEM *of Boiler Water Conditioning*

THE CLEVELAND TRACTOR COMPANY

BUILT TO ENDURE

CLEVELAND, OHIO
U. S. A.

November 3, 1936

The Hoffman Combustion Engineering Co.,
410 Ford Building,
Detroit, Michigan.

Gentlemen:

We installed three Hoffman Firite Automatic Stokers under Erie City 150 HP - HRT Boilers in October, 1933. One more unit was installed in October, 1934. As yet, we have had no maintenance cost on these stokers.

During the last winter, due to coal shortage we used nut and slack coal from Ohio mines. For at least thirty days we burned Miner's slack exclusively until we were able to procure our regular supply.

These stokers have performed satisfactorily in every way. We will be more than pleased to show our Hoffman Firite installation to anyone interested.

Very truly yours,

THE CLEVELAND TRACTOR COMPANY

A. Fussner
Maintenance Engineer

AF:fm

"No Maintenance in 3 YEARS"

"Satisfactory in Every Way"

"Burned 'Miner's slack' during coal shortage"

THE CLEVELAND TRACTOR COMPANY

Cletrac

CLEVELAND, OHIO
U. S. A.

September 21, 1942

The Hoffman Combustion Engineering Company
Marquette Building
Detroit, Michigan

Gentlemen:

We are writing you in regard to the maintenance cost on our four Hoffman Automatic Stokers, covering the period from 1933 to date.

The average cost has been $3.45 per stoker per year, covering the nine-year period.

In view of the above figures, we are more than pleased with Firite Stokers, and when we install additional stokers, we would not be satisfied with any other than "Firites".

Very truly yours,

THE CLEVELAND TRACTOR COMPANY

A. Fussner
Maintenance Engineer

AF:fm

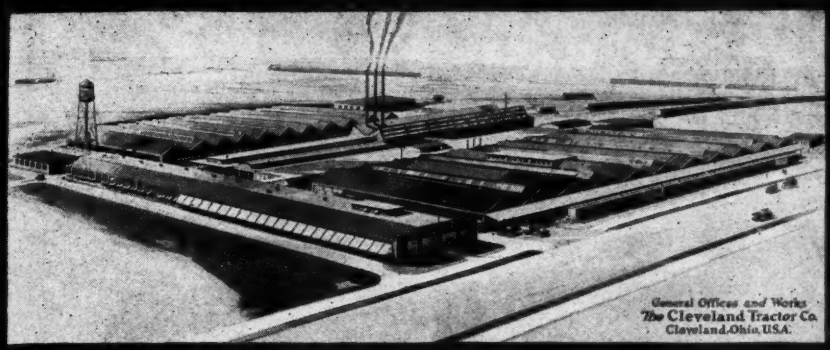
"AFTER NINE YEARS"

"TOTAL MAINTENANCE $3.45 PER STOKER PER YEAR"

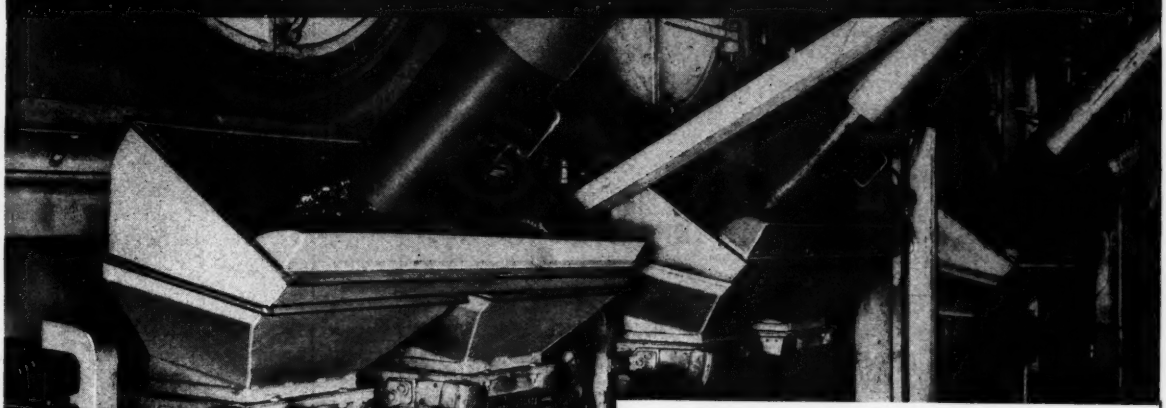
The OLIVER CORPORATION also has HOFFMAN STOKERS in its plants at South Bend, Indiana and at Springfield, Ohio

HOFFMAN COMBUSTION

WORKS AT: FAIRMONT, WEST VIRGINIA
DETROIT, MICHIGAN



6th Firite STOKER



"Steam Load constantly increasing"

. . . After 13 Years

"NO INCREASE IN MAINTENANCE"

The OLIVER Corporation
19300 EUCLID AVENUE · *Cleveland 17, Ohio* ·

August 23, 1946

Hoffman Combustion Engineering Co.
Marquette Building
Detroit, Michigan

Gentlemen:

When I took over my present duties from my predecessor, we had five Firite stokers installed in our boiler plant, the fifth having been installed in 1943. The performance of all five has been so uniformly satisfactory that we are now stokering our sixth and last boiler with Firite.

We have found that we could burn any grade of coal economically and at the same time had no trouble carrying a steam load which has been constantly increasing due to plant expansion.

Maintenance costs have been extremely favorable, at no time exceeding the figure quoted by our letter to you in 1942.

Our satisfaction with these stokers and our pleasant relations with your company has been such that we do not hesitate to give Firite stokers our unqualified endorsement.

Very truly yours,

THE OLIVER CORPORATION

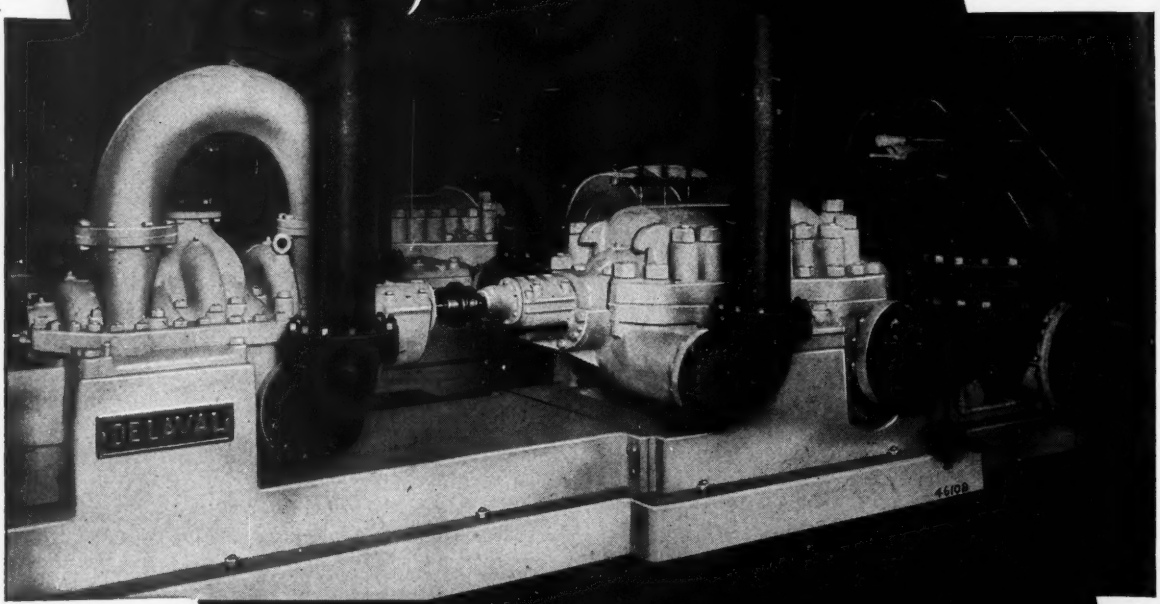
A. P. Herrick,
Superintendent of Maintenance

aphieh

ENGINEERING COMPANY

OFFICES: Marquette Building, Detroit, Mich. Bell Building, Chicago, Illinois
154 Nassau Street, New York City Twenty-Two Marietta Bldg., Atlanta, Ga.

THE DEPENDABLE DRIVE *for* BOILER FEED PUMPS



a DE LAVAL TURBINE

In the boiler room, where live steam is readily available, De Laval turbines, either direct connected or geared, are the logical drive for boiler feed pumps, induced or forced draft fans, stokers and other equipment.

De Laval mechanical drive turbines are dependable and independent of electrical supply disturbances. They are economical to operate and speed is readily controlled.

Submit your drive problems to De Laval engineers for expert, helpful advice based on close to a half century of experience in turbine development and application.

T-3

TURBINES · HELICAL GEARS · WORM GEAR SPEED REDUCERS · CENTRIFUGAL PUMPS · CENTRIFUGAL BLOWERS AND COMPRESSORS · IMO OIL PUMPS

DE LAVAL STEAM TURBINE COMPANY
TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA · BOSTON · CHARLOTTE · CHICAGO · CLEVELAND · DENVER · DETROIT · DULUTH · EDMONTON · GREAT FALLS · HAVANA · HELENA · HOUSTON · KANSAS CITY · LOS ANGELES · MONTREAL · NEW ORLEANS · NEW YORK · PHILADELPHIA · PITTSBURGH · ROCHESTER · ST. PAUL · SALT LAKE CITY · SAN FRANCISCO · SEATTLE · TORONTO · TULSA · VANCOUVER · WASHINGTON, D. C. · WINNIPEG

ROTO
TUBE CLEANERS
for BABCOCK & WILCOX
Integral-furnace Boilers

The unusual three-pass tube arrangement in the B & W Integral-furnace Boiler permits maintenance of high operating efficiency because ease of cleaning tubes was a primary consideration in the design.

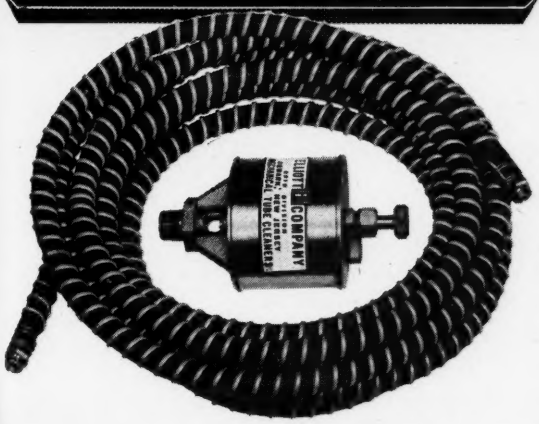
Tubes in the first pass, which are subjected to the most severe conditions, and are most likely to accumulate scale, are 3¼ inches in diameter and easily cleaned with a Roto Model 125 Motor with four-arm head. Second- and third-pass tubes are smaller and more closely nested for maximum heat transfer. Roto Tube Cleaners for these tubes are also illustrated.

It is a high tribute to the efficiency of Roto Tube Cleaners that so many boiler manufacturers furnish them as standard equipment. Cleaners for practically any standard boiler are now stocked, ready for shipment, awaiting your order.

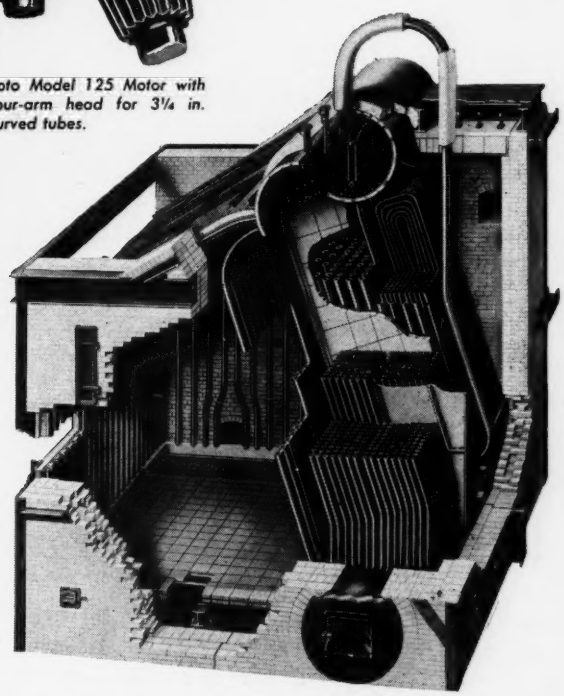
Roto Model 120 Motor with three-arm head for 2½ in. curved tubes.

Roto Model 226 Motor with pivot head and drill head (not shown) for 2 in. curved tubes.

Roto Model 125 Motor with four-arm head for 3¼ in. curved tubes.



Roto special left-hand wire wound tube cleaner hose and Roto lubricator.



Cutaway view of the B & W Integral-furnace Boiler showing unusual three-pass tube arrangement.

ROTO Division of ELLIOTT COMPANY
147 SUSSEX AVENUE - - - NEWARK 1, N. J.

. . . but some water treatments are still based on Rumor and Folklore

says:

L. Pulral

Nalco Representative
Northern Illinois

Some of the Folklore Water Treatments

Only a few of the strange materials Nalco engineers have found being used as boiler water treatments are shown here. Some are partially effective . . . Others are actually dangerous.

EVEN those of us who make a business of bringing water treatment systems up to date get a surprise now and then when we find instances where the water treatment was apparently dictated by rumor or folklore, or both. Putting the Nalco System to work in such a plant is usually spectacular . . . Simply because of the vast improvement in boiler and general plant performance. And this difference, in varying degrees, is usually apparent when the Nalco System begins to operate in any plant.

A Nalco survey and recommendations (if necessary) for complete, scientific water treatment in your plant will cost you nothing—may be the means of substantial savings in overall plant operating costs. Write today for complete information.

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Avenue, Toronto, Ontario

The Scientific Water Treatment for All Industry

Nalco

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS, AUXILIARIES

1 **Gas Scrubbers and Coolers**—Here is a four-page bulletin that tells about the company's line of gas scrubbers and coolers and tells how this equipment serves industry. Line drawings are used to show the flow of gases through the scrubber and also to show the manner in which gases and liquids flow through the multi-stage cooler. Operating principles of the various parts are described in detail and the units' construction is outlined. Bulletin No. H-202. Peabody Engineering Co.

2 **Standardized Boilers**—Bulletin 746 is a four-page catalog describing this new development in the company's line of boilers—the Type M. Standardized Boiler is available in 12 models from 6,000 lb. per hr. of steam to 17,000 lb. per hr. The bulletin presents cross-sectional views of the unit and describes the features. A chart is presentd to show the operating efficiency of the boilers. "How to Order" information is also given. Springfield Boiler Co.

3 **Boilers**—Bulletin No. 110, describing this manufacturer's "Perfect Balance" Boilers, is a 4-pg. item and is designed to present capacity tables, dimensioned drawings and a full page cutaway wash drawing of the unit. John Phillips Badenhausen, Inc.

4 **Central Heating, Steam Distribution**—A case study of the Firestone Industrial Community at Akron, Ohio, in relationship to the central heating system installed is the subject of this new 8-page bulletin. Layouts of the piping system are included as are photos of the plant, the installation of the system and features of the steam generation and control. The Ric-Wil Co.

5 **Inserts for Condenser Tubes**—This 8-pg. bulletin tells about this company's metal inserts or wearing strips for inlet ends of condenser tubes. It tells why condenser tube failure so often takes place and also points out, by means of explanatory text, diagrams and actual photos how these inserts help protect against this wear. A report of tests made by the Massachusetts Institute of Technology is a part of the bulletin. Condenser Service & Engineering Co., Inc.

6 **Slag Removal**—Bulletin 454 tells about this company's product which was developed to remove hard slag and other combustion deposits from tubes and other metal boiler surfaces, and from furnace refractory walls, by chemical means. It is pointed out that this vapor is blown into the furnace walls while it is in regular operation. Its use minimizes the necessity for taking the boiler off the line to do the cleaning job manually. Gamlen Chemical Co.

ELECTRICAL

7 **Free Transformer Demonstrator**—Here is a clever demonstration chart (SA-900) which was designed to show how banked secondary transformers operate under overload or fault conditions. Transformer operation under various system conditions is indicated by means of a disc which turns to show operation of bimetals and signal lights as the load on the transformer increases. It shows the opening of contacts and darkened houses when the fault or excessive overload is sectionalized. The reverse side of the chart discusses the advantages of the CSPB transformers in banked secondary systems. Westinghouse Electric Corp.

8 **Fomulas and Charts for Capacitor Work**—On a sheet 22 in. by 16 in. this company has prepared a chart for determining capacitor kvar required to increase power factor to any desired value. Beneath the chart, on the same page, are complete instructions on the use of the chart with a typical example worked out on a miniature reproduction of the chart. On the opposite side of the chart sheet are presented several formulas for capacitor application. Also presented in this same section is a table titled, "The Effect of Improving Power Factor on a 3 Phase Circuit in Conduit." Capacitor equipment of the manufacturer is shown on the upper part of the reverse side of the sheet. Cornell-Dubilier Electric Corp.

9 **Varnish for Electrical Equipment**—"How To Use DC 996," is the title of this recently issued 4-page bulletin. The bulletin is designed primarily for the man who rewinds and maintains electrical equipment and it contains practical instructions on how to apply and cure DC 996, a silicone varnish which cures at ordinary baking temperatures and protects electrical equipment operating continuously at temperatures up to 350 F and which are subject to excessive moisture. Also included in the booklet are tables giving the properties and specifications for DC 996 and a summary of the advantages resulting from use of this varnish for impregnating electrical machinery. Dow Corning Corp.

10 **Electrical Products**—This 16-page letter-sized handbook of electrical products for a wide variety of industries has just been announced by this company. Well illustrated, the handbook describes eight classifications of electrical equipment ranging from a-c and d-c motors from ½ to 50,000 hp to electronic heaters. For easy reference the booklet tabulates characteristics of motors from ½ hp to 75 hp and describes the construction and application of many types of motors built by the company. On motor control equipment, the booklet offers data covering the type, maximum horsepower, volts and description. Similarly, in describing the company's line of of multiple V-belt drives of constant and variable speeds, a table provides at a quick glance information relative to the type of sheave, number of grooves, belt sizes and horsepower best fitted for a particular purpose. Allis-Chalmers Mfg. Co.

11 **Mechanical Principles of Electrical Connectors**—This is a 12-page illustrated book, (No. 466) printed in two colors, which has been compiled by this company to assist engineers, jobbers, contractors and industrial purchasing agents in acquiring an exact understanding of the design and function of these electrical connectors. Cut-away models and schematic diagrams are used to illustrate the descriptive matter. Factual analyses of the mechanics involved to achieve ample contact area and the permanence of high contact pressure are also presented. National Electric Products Corp.

12 **Induction Motors**—Bulletin No. 720, 12 pages, covers the company's line of squirrel cage induction motors. Features of the unit are outlined and pages are devoted to the construction details of the motors. Each of the construction features is accompanied by a photograph illustrating the particular feature under consideration. Two pages are devoted to photographs of typical applications. The Louis Allis Co.

13 **Transformers for Secondary Banking**—How CSPB (Completely Self-Protected) transformers can overcome disadvantages of conventional banked secondary systems for improved service and reduced cost is explained in this new booklet B-3777. The 16-page booklet diagrams radial, network and conventional secondary banking systems, as well as the new banked secondary method for obtaining protection with a completely self-protected transformer which contains a circuit breaker in addition to the one required for thermal protection. This arrangement eliminates secondary fuses, sectionalizes without taking transformers out of service, and makes it possible for all transformers to carry full capacity. The booklet explains, with the help of schematic diagrams, how this transformer clears faults, indicates tripped breakers and gives load indication. Westinghouse Electric Corp.

WELDING

14 **Electrodes and Welding Rods**—A new and complete 64-page catalog of all the company's electrodes and National oxy-acetylene gas welding rods has just been announced. Included are complete specifications, descriptions, identifications, physical properties, welding procedures and recommended ranges and sizes available in the complete line of electrodes—mild steel, alloy steel, stainless, hard facing, cast iron, etc. There are tables on the weldability of metals, appearance inspection of welds, electrode consumption estimating chart and definitions of welding terms. Hollup Corp.

15 **Welding Procedure Sheets**—Two new arc welding procedure sheets have just been issued by this company. They are titled "Procedure for Welding Silicon Bronze," and "Welding Procedure for Beryllium Copper." The papers discuss the recommended electrode, polarity and current, preparation and preheat, and detailed technical data on the base metal under consideration. Ampco Metal, Inc.

PUMPS, COMPRESSORS

16 **Centrifugal Pumps**—Bulletin 240 is a 6-page folder describing the company's single stage, double suction, Type DBL centrifugal pump. Features of the pump resulting from its construction and engineering are described on the second page of the folder. The next spread presents a sectional view which is used to point out other advantages of the unit. Tables of metal specifications and capacity ratings in gallons are also given. Warren Steam Pump Co., Inc.

17 **Pumps Bulletin**—Bulletin D246 is a recently-issued, 8-page catalog which describes this company's line of SCV pumps. The pumps are in use in the following types of service: cold water circulation, brine circulation, sprinkler systems, pressure boosting, air conditioning systems, hot water circulation. The bulletin presents construction parts lists, shows how maintenance is a simple job, gives dimensional data, ordering information and suggested specification form. Comparisons with other types of pumps are made. A selection table, based on various services, is another feature of the booklet. Economy Pumps, Inc.

18 **The ABC's of Turbo-Blowers and Rotary Compressors**—The ABC's of the company's turbo-blowers, rotary compressors and vacuum pumps are explained fully in a 16-page booklet designed for student training. The book tells what these units are, how they operate and how to figure them. It is cleverly illustrated and shows the simple construction of the turbo-blower and tells why it is important that complete information be furnished to figure blowers correctly. Reproduced are curves depicting pressure volume, influence of water vapor on volume, and correction curves for volumes to maintain constant air weight with changes in temperature and barometric pressure. Allis-Chalmers Mfg. Co.

INSTRUMENTS, CONTROLS

19 **Portable Pyrometer**—Bulletin D602-4 is a four-page issue which tells about this company's portable pyrometer line. Full details pertaining to the new lance pyrometer are given and also for the portable pyrometer kit. Specifications for the proper selection of extension holders, adapters and thermocouple tips are listed in chart form. Wheelco Instruments Co.

20 **Oil Measurement, Control**—Accurate measurement and control of heavy fuel oil by means of the "Transometer" is the subject of this 4-page bulletin. It is pointed out in the bulletin that the "Transometer" makes possible control, integration, remote indicating and recording of this hard-to-handle fuel. Three applications of the "Transometer"—Combustion Control, Furnace Atmosphere Control with Alternate Fuels, and Furnace Atmosphere Control with Two Fuels Used Simultaneously—are pictured with line drawings and are explained briefly. A description of the unit itself is given and operating characteristics are outlined. Askania Regulator Co.

(Continued on page 54)

OCTOBER, 1946

POWER PLANT ENGINEERING

53 W. Jackson Blvd.. Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph number.

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Please Print Clearly

Your Name .....

Your Title .....

Your Company Name .....

Company Address .....

City..... **State**.....

(If you prefer delivery at your home also fill in below)

Home Address .....

City..... **State**.....

21 **Water Gages Bulletin**—Bulletin E is a recently-issued catalog of the company's line of water gages for stationary, marine and locomotive boilers and for use on tanks. The bulletin is filled with compact information—tabular material, photograph and description—of dozens of different water gages. Descriptive data is condensed and easy to follow and the illustrations point out many of the listed features. Ernst Water Column & Gage Co.

22 **Instruments In Industry**—This is a four-fold broadside telling about the company's line of instruments and instrumentation engineering and service throughout the country. Pictured and described are automatic controllers, flow meters, recording thrmometers, electric recorders, pH recorders and controllers, pyrometers and many other instruments and controls. The Bristol Co.

23 **Process Controls**—Instruments and controls for the process industries is the subject of this recently-issued four-page Bulletin No. 17. Process controllers, control components, measuring components and instrument combinations are briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed for the various components. Typical control systems of both the single and multiple element type are illustrated and described. Bailey Meter Co.

24 **Bulletin on Tachometers**—Bulletin S1400 describes the company's line of tachometer recorders and indicators. Twelve pages are included in the bulletin which presents a complete description of the potentiometer-type tachometer together with a description of the millivoltmeter-type indicating, and strip-chart recording tachometers. Outstanding features of the booklet are complete wiring diagrams, application data and details of a typical installation. The Bristol Co.

25 **Diaphragm Gage Bulletin**—Straight line diaphragm gages for stationary and marine service are described in Bulletin 24A issued by this company recently. A complete description of the many features of the gage are given and line drawings and photographs illustrate the described points. Tabular material describing gage and drilling dimensions and standard scales in inches water column are presented. Ellison Draft Gage Co.

DIESELS

26 **Diesel Electric Sets**—A new booklet titled, Caterpillar Diesel Electric Sets," features picture stories of the sets in operation and, at the same time, tells about the features of the units. Twenty pages are included in the book and they cover six different models. Typical installations for communities and small industries are briefly described and pictured. Details of construction and features of operation and economy are covered in the last several pages. Caterpillar Tractor Co.

27 **Marine Diesel Engines**—Marine-type Diesel engines are described in Catalog 173 which was issued recently. There are 22 pages in this catalog. Six different models are described and illustrated on the first six pages of the folder. Next, there are two pages which show photographs of typical installations of these Diesel units. Three more models are described on the following three pages and then detailed descriptions of features common to all nine models are considered. A full-page table of ratings and dimensions is presented on the last page of the catalog. Enterprise Engine & Foundry Co.

28 **Flexible Pipes for Diesel Installations**—Bulletin 71 is a recently-issued piece of literature, containing 8 pages, which describes the use of this all-metal flexible hose for exhaust and supply lines for Diesel installations. Typical installations, ashore and afloat, using the hose are pictured. Tables of tube sizes, bending radii, weight, length, etc., are presented for fuel oil and starting air lines, for lubricating oil and circulating water lines. The safety, ease of installation and takedown of this tubing when used as exhaust pipes is explained. Pennsylvania Flexible Metallic Tubing Co.

29 **Diesel Operation Book**—There are 116 pages in this recently-issued book titled, "Diesel Operation, Fuel and Lubricants." The book is crammed full of up-to-the-minute information. The following chapter headings will give some idea of the scope of the contents: Diesel Fundamentals, Diesel Engine Performance, Bearing Lubrication, Supercharging, Air Compressor Lubrication, Selection of a Diesel Fuel, Bearing Difficulties, Ring and Cylinder Wear, Fuel Injection Maintenance, Trouble Shooting Guide, and many others. The book is well illustrated and has many tables for reference. The Texas Co.

WATER CONDITIONING

30 **Clarifying and Softening Water**—This 8-page catalog titled "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration," was issued recently. The first part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation. Two pages are devoted to a sectional diagram through a reactivator and the accompanying copy tells about the unit's features. Actual installations are pictured and described. Graver Tank & Mfg. Co., Inc.

31 **Basic Water-Softening Methods**—This new water softening booklet describes basic water softening methods for industrial, institutional, and municipal use. The water softeners, ion-exchanging type, are of both pressure and gravity types which feature automatic equipment to control backwashing, brining and rinsing processes. The Permutit Co.

LUBRICATION

32 **Lubrication Handbook**—This 16-page lubrication chart is a veritable handbook on the lubrication of American Diesel engines—stationary, bus and truck, tractor and railroad, and marine. Names and models are given and the lubricants recommended for winter and summer operation are listed in tabular form. The Texas Co.

33 **Lubrication Handbook** — Well - illustrated service handbook describes Lubriplate lubricants and their application on shafts, ball and roller bearings, chain drives, gears and other machinery. Also tells how to use Lubriplate for rust proofing engine parts, piping, fittings, tanks, etc. Fiske Refining Co.

MECHANICAL TRANSMISSION

34 **V-Belt Drives**—"How the Dominant Drive Speeds Production," is the title of this 16-page illustrated booklet. The booklet does not go into engineering details of the multiple V-belt drive; instead, it presents the results of these engineering features in terms of operating advantages to users. Typical chapter headings are: "Delivered Horsepower," "Drive Durability," "Adaptability to Fluctuating Production Schedules," "Savings in Man-Hours and Shop Space." The booklet is especially valuable to executives and foremen responsible for efficient and economical plant operation. Multiple V-Belt Drive Assn.

35 **Power Transmission Handbook** — This Handbook AED-45 consists of 72 pages of closely packed information on motor mountings and belt drives. Tabular material—drive selection tables, dimension tables, installation instruction data, tables of sheave information, list prices and flat belt drives—is an outstandingly useful section of the book. The selection of special drives is completely outlined and explained. The book is well illustrated and arranged for maximum usefulness and readability. The American Pulley Co.

36 **Drive and Conveying Digest**—Catalog D-1 is a 16-page digest, profusely illustrated, which gives pertinent information on drive and conveying chains and sprockets, finished steel roller chains and sprockets, silent chains and sprockets and flexible couplings. Exploded views of the chains and sprockets clearly show construction and assembly. List prices, dimensions and weights are given in tables on single, double, triple and quadruple width roller chains and for silent chains. Drawings and tables of flexible couplings are also given. Union Chain and Manufacturing Co.

MISCELLANEOUS

37 **Steam Plant Data**—"Dividends from Your Power Plant" is the title of an interesting booklet, telling in non-technical language what engineers and plant managers ought to know about generation and boiler efficiency. Preferred Utilities Co.

38 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co.

39 **Handbook on Filters**—This 48-page handbook on filters covers the company's entire line of industrial filters. Indicative of the scope of the book are some of the chapter headings: "What is Filtration Efficiency?" "The Filtration of Oil and Air for Internal Combustion Engines and Compressors." "The Purification of Compressed Air for Engineering Industrial Purposes," "Reducing Wear in Generating Station Machinery," "Protecting Electrical Equipment from Dust Erosion," and many others. The book is well illustrated with photos and wash drawings. Drico Industrial Corp.

40 **Convector Radiation Bulletin** — Bulletin 246 is a 16-page booklet describing the company's new, completely non-ferrous heating unit and additional enclosure types and sizes. Cut-away and installation photos and dimensioned line drawings which are accompanied by tables of dimensions assist in showing how the units should be installed. Installation procedure for each type of convector is given. Modine Manufacturing Co.

41 **Expansion Joints Data Book**—This 12-page catalog 268M covers the company's line of expansion joints, anchor joints and low pressure-large diameter expansion joints. Presented in the booklet are complete engineering data, dimensional tables and specifications for these fittings. It also contains information on other products, recently developed, such as, offset, turbo and jacket joints and includes material on high temperature exhaust bellows and heavy duty Clinch-Lock bellows. A description of the company's engineering service is also presented. Magnilastic Division, Cook Electric Co.

42 **Flexible Tubing and Fittings**—These two bulletins, G-6 and 90, cover the company's high pressure flexible all-metal tubing, and metal hose and tubing for air, oil, steam, gases and volatiles and for any place "where leaks are fatal." Bulletin 90 is an 8-page issue filled with diagrams and suggested installations. "Tough spots" where vibration, heat or movement may cause trouble are described and the bulletin shows how the tubing can overcome these problems. Tables of sizes are given. Pennsylvania Flexible Metallic Tubing Co.

43 **Pipe Pusher**—Four pages are included in this bulletin telling about the company's recently developed pipe pusher for pushing ¾ in. to 2 in. pipes. Besides listing the features and advantages of the pipe pusher the bulletin tells how it operates and shows various photographs of the pusher in use. Construction Equipment Co.

44 **Dust Collecting**—This 8-page bulletin goes into considerable detail on case studies of dust collecting and also on the company's equipment which is used to do the work. The simplicity of the dust tubes which do the work is pointed out and the ease with which these tubes are cleaned or changed is described with words and pictures. The bulletin is generously illustrated. American Foundry Equipment Co.

45 **Vibration Insulators**—A new booklet on its line of Vibro-Insulators has just been issued by this company. The booklet gives an outline for the proper selection of vibration insulator for specific requirements and cites a large number of typical applications. A complete table of characteristics of each type of insulator adds to the usefulness of the booklet. Charts are presented which show inches of deflection on the insulators under various loads. The B. F. Goodrich Co.

46 **Vacuum Cleaners**—Heavy Duty portable vacuum cleaners are described in this recently issued bulletin. The dangers of uncollected and uncontrolled dust are explained in the fore part of the booklet and the bulletin then goes on to tell about the vacuum cleaners—their construction, operation and features. Line drawings and photographs aid the explanatory matter in giving a complete, clear description of the product. U. S. Hoffman Machinery Corp.

47 **Insulation News**—A new quarterly publication, The Magnesia Insulation News, has just appeared with its first number. Its purpose is to serve as a medium between the makers of magnesia insulations throughout the industry and the users of the insulation. Uses and advances in the manufacture of magnesia insulation will be covered in this newspaper. It is to be distributed free of charge. Magnesia Insulation Manufacturers Assn.

48 **Floor Treatment**—This new Specifications Book "B" covers treatment for concrete and wood floors; it is divided into five sections as follows: 1. Integral hardeners—metallic types, including non-slip hardeners; 2. chemical hardeners—liquids which are swept or brushed over concrete floors; 3. concrete dye; 4. surface coatings—rubber base floor coating; transparent sealers, and non-slip mastic or covering; 5. wood floor preservatives, including varnish. The book contains both complete and "short" specifications, illustrations and descriptions of the product. Truscon Laboratories, Inc.

49 **Fire Fighting**—"How to Fight Fires and Protect Property," is the title of a recently issued 24-page booklet, Catalog R-5827. This handy folder graphically explains and illustrates the latest techniques in fighting fire with carbon dioxide and other types of fire extinguishers. It answers, with photographs and diagrams, such questions as "What type fire hazards should I recognize?" "How can I mobolize my fire defense?" "What is the correct spacing and bracketing height for various type fire extinguishers?" Randolph Laboratories, Inc.

50 **General Catalog on Gaskets**—This new catalog No. 303 gives a complete illustrated description of the company's line of gaskets, both standard and special in various types of construction and of different materials and metals. It is pointed out that this catalog describes a line of gaskets which covers all temperature and pressure requirements which are encountered in industrial, marine, chemical, petroleum and power plant applications. In addition to the catalog material, handy gasket engineering reference tables are included; these show comprehensive data on sizes, shapes and temperature conversion together with other pertinent gasket information. United States Gasket Co.

(Continued on page 164)

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE, and COPPER*

Investigation of Tube Failures Leads to Selection of Better Alloys

The extensive field studies made by Bridgeport metallurgists, in cooperation with marine and power plant engineers, are playing an important part in lengthening tube life and in laying the groundwork for improved operating efficiency.

Service conditions, which are not generally the same in two different localities, and often vary even in two similar condensers in the same plant, are responsible for excessive corrosion resulting in shutdowns and interruptions in the flow of power or vital production.

In many cases, it is possible to select one or another of the existing condenser tube alloys which will best withstand given conditions. However, the subject of corrosion is a complex one, and each installation should be treated as a special case.

Microstructure No Influence on Corrosion Resistance

There has been no evidence presented to date which would indicate any direct relationship between microstructure (fine grain, coarse grain, non-uniform grain or cold worked structure) and service life.

It has been thought by some that a particularly fine grained structure was essential to tube endurance. Because of the fact that the tubes in a condenser will usually show a considerable variation in grain size, it would follow if this were true, that the earlier failures would generally occur among the coarser grained tubes, while the finer grained ones would show a comparative absence of them. Repeated examinations by our Research Department have failed to detect the existence of any such relationship. Numerous instances have been found in which the failed tubes exhibited the finer structures.

Effect of Composition

The addition of one or more alloying elements to copper produces alloys with varying degrees of corrosion resistance. For example, tin, silicon, aluminum, nickel, iron, zinc, arsenic, etc., added singly or in combination result in the standard condenser tube alloys. These alloys vary greatly in their corrosion resistance to sea water, fresh water, polluted waters, hydrogen sulphide, ammonia, pharmaceuticals, organic or inorganic acids, salts and alkalies, as well as to stress corrosion.

Generally, when it is possible to obtain all the facts in a given instance of long condenser tube life or premature failure, some unsuspected difference in alloy composition, water composition, or other factor will be revealed. It was only through long and careful studies that British condenser tube investigators discovered that arsenic in small concentrations is effective in preventing dezincification in brass.

Corrosion Research

The research work which is constantly being carried on by Bridgeport's laboratory includes investigations dealing with the behavior of different metals and alloys when partly or completely immersed in various corrosive media such as sea water, acids, alkalis, etc. The data obtained when correlated with information gathered from our field experience are helpful in the recommendation of existing alloys for specific conditions as well as in the development of new and improved alloys.

It has been found, for example, that by the addition of a small percentage of an inhibitor to the solution, the corrosive action of an acid such as dilute sulphuric can be reduced to such an extent that no attack takes place even at the water line although similar samples in the same solution but without the inhibitor will dissolve completely at the waterline in 2½ months.

Likewise, the addition of a small percentage of alloying material may have a profound effect on an alloy's resistance to certain types of corrosion. Such studies point the way to the development of alloys with increased corrosion resistance.

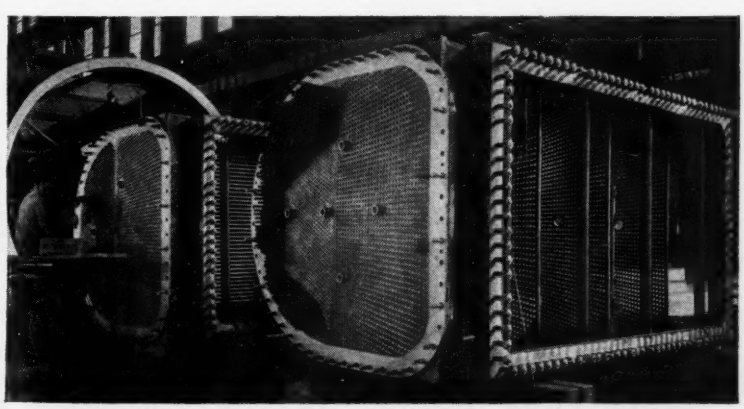
In most environments metals tend to change into some more stable combinations, such as the metallic ores from which they were obtained. Moisture or water accelerates the return of the metal to metallic compounds. It is for this reason that we are generally more concerned with the corrosion of metals called upon to handle naturally occurring waters and industrial solutions or liquors than with metals which are kept in a dry state.

Much valuable data has been collected through the years on the service life of various condenser tube alloys used under many different types and conditions of operation. Naturally, close cooperation between the power plant operator, his own laboratory, if he has one, and the Bridgeport laboratory, pays off. Careful records covering the behavior of existing tubes and that of sample alloys will prove invaluable when it is necessary to decide which tube alloy should be selected when retubing is in order.

Many problems confront the operator, and our Laboratory is asked to help solve problems such as the following:

- Which alloy will give best results when retubing?
- How to increase corrosion resistance.
- How can heat transfer be improved?
- How to reduce effects of Biofouling.
- How to reduce dezincification. Pitting.
- How to resist impingement corrosion.
- How to prevent premature failure from cracking.
- How to resist corrosion from organic pollution.
- What effect will a certain amount of ammonia have on the steam condensate?
- Is there a critical water velocity?
- What is life expectancy of tubes?
- Effect of pH on condenser tube life, and many, many others.

Write for a copy of Bridgeport's 112-page Condenser Tube Manual. Call our nearest office for any service we can render through our Laboratory or Technical Service Department.



Tubing of two 7,500 sq. ft. Surface Condensers—Courtesy Allis-Chalmers Mfg. Co.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • *ESTABLISHED 1865*

Here are the benefits you get from

BAILEY CONTROLS

1. **Fuel Conservation without decrease in output.**
2. **Lower Cost Steam.**
3. **Increased Safety for Plant and Personnel.**
4. **Better Power Service.**

Bailey Controls for boilers make the important factors of steam plant operation work together to insure ideal performance.

In order that all of these factors may be regulated in harmony with each other and the load demand, Bailey Controls are carefully engineered to the requirements of the units which they serve.

Bailey engineering service starts with the selection of suitable metering and control equipment and continues through the design, construction, calibration, installation and final adjustment on the job. Bailey field engineers are stationed in over thirty industrial areas throughout the United States and Canada for the purpose of rendering prompt "on the spot" engineering service without undue traveling expense.

The Bailey engineer in your community has extensive experience at his command, which includes tests on thousands of boiler installations, covering a wide range of fuels, furnaces and fuel burning equipment. He is in a position to help you secure the many benefits resulting from intelligent use of correctly selected and properly applied boiler control.

Bailey Controls for boiler operation are described in Bulletin 15-C. Write for your copy to Bailey Meter Company, 1040 Ivanhoe Road, Cleveland 10, Ohio —in Canada to Bailey Meter Company Limited, Montreal.

FUEL CONVERSION

If it becomes desirable or necessary to convert to another fuel, Bailey Controls can be adjusted easily to insure optimum results from the new fuel.

G-26

BAILEY METER COMPANY

1040 IVANHOE ROAD • • • CLEVELAND 10, OHIO

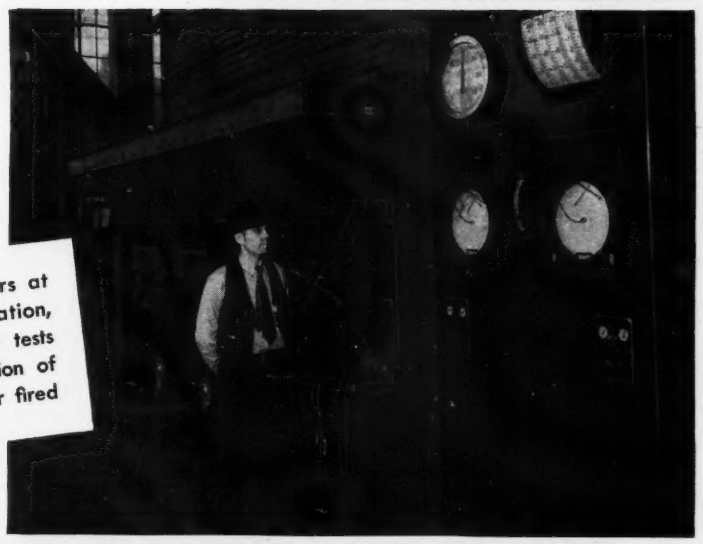
Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

APPLICATION to STOKER FIRED BOILERS

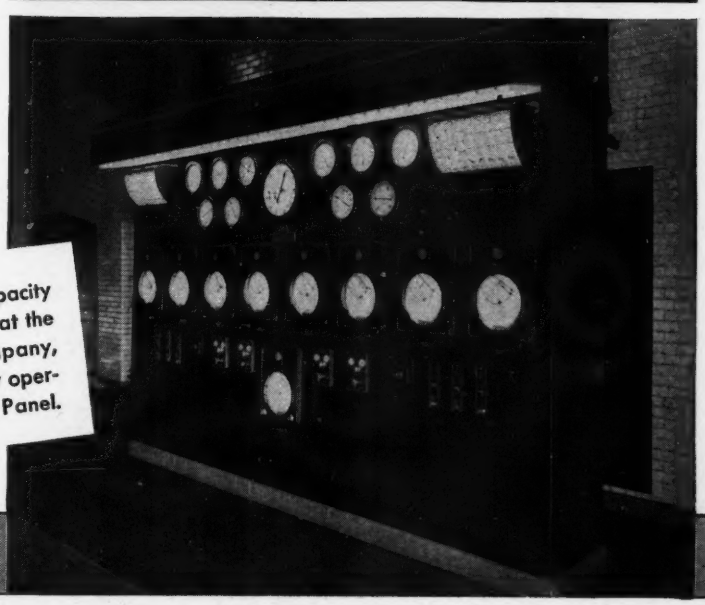
UNDERFEED

This Bailey Control Panel insures optimum performance from three underfeed stokers on two 25,000 and one 40,000 lb. per hour capacity boilers at Parker Appliance Company, Cleveland, Ohio.



SPREADER

Bailey Controls help operators at Graham-Paige Motors Corporation, Detroit, Michigan, to maintain tests standards in everyday operation of this 60,000 lb. per hour boiler fired by a spreader type stoker.



CHAIN GRATE

Two 40,000 lb. per hour capacity chain grate stoker fired boilers at the United States Tobacco Company, Chicago, Illinois, are efficiently operated by this Bailey Control Panel.

Every Month for 15 Years...

THE BETZ INDICATOR

IT has always been the policy of the Betz organization to publish and distribute informative literature pertaining to the many-sided subject of industrial water conditioning. As new developments occur, or as established practices are improved upon, we publicize the information. To date, we have offered more than 150 technical papers, bulletins and reference handbooks—all dealing with industrial water conditioning or some closely allied subject.

Typical of these many publications is the *Betz Indicator*, which has been issued monthly—without interruption—for fifteen years. Each issue features one or more topics concerned with water conditioning or water analyses, in addition to other articles of universal interest to the engineer. The illustration for the cover page shows water in some form and is chosen from a selected group of salon photographs. From a modest beginning, circulation has now reached 15,000 copies—with mailings to every state in the Union, every province in Canada, and to many foreign countries.

Yes, month after month after month the *Betz Indicator* is mailed to thousands of chemists, engineers, plant superintendents and others interested in the vitally important subject of water conditioning. If you, too, would like to receive it without cost or obligation, all you need do is make the request on your company letterhead.

W. H. & L. D. BETZ • 4557 Worth Street • Philadelphia 24, Penna.

BETZ

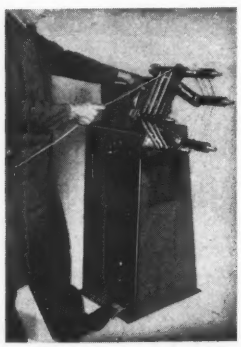
BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

NEW EQUIPMENT NEWS

The new equipment items in this section are identified by letters which precede the headings. When further information is desired regarding any of this equipment write this corresponding letter on the coupon in the Helpful Bulletins section, cut it out and send it to Power Plant Engineering, 53 West Jackson Blvd., Chicago 4, Ill.

A New Coil Winder Drive. Ideal Industries, Inc. announces a new coil winder drive, which is especially designed for fractional horsepower motor winding.

Operation has been simplified to only two controls and a clutch in obtaining a speed variation of 41 to 410 rpm. Turns are recorded by an



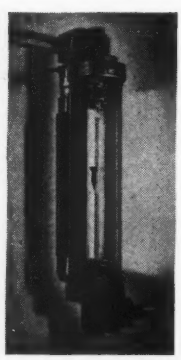
Odometer type counter which is in full view of the operator.

Driven by a ½ hp (1750 rpm) motor through a spur gear drive, maximum torque or pulling power is delivered to the winding head. These spur gears are carefully machined to assure smooth, quiet operation without "back lash" or starting lag.

The torque is 77 in. pounds at "fast" speed and 770 in. pounds at "slow" speed. At a speed of 41 rpm using an Ideal universal coil winding head, the drive will wind a 7½ in. round coil of No. 6 AWG wire, or a 16½ in. coil of No. 9 AWG wire.

Floor space required is 19 in. x 20¾ in. Weight of drive is 250 lb.

B Rotameter Lighting Device. A newly perfected, inexpensive lighting device for the new SK Universal Rotameter has just been introduced by the Schutte & Koerting Co. Since many Rotameters are installed in poorly-lighted locations, its use assures easy, accurate readings. The device, a baked-enamel metal hood with narrow frontal opening, fits snugly against the back of the Rotameter tube and

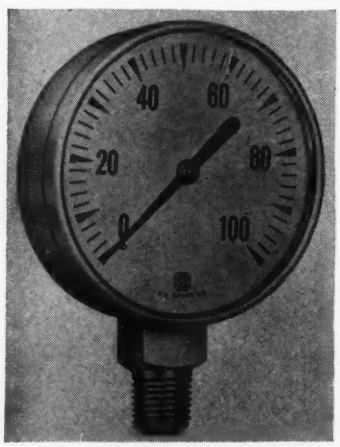


directs a beam of light through the glass toward the operator. Thus rotor and meter scale are clearly outlined even when the metered fluid is semi-opaque in character.

The lighting unit can be easily attached to any SK 250 mm length Universal Rotameter by means of a bracket furnished with each device. Push-button socket, 10 ft rubber-covered attachment cord and plug are included. It uses a 110-v tubular incandescent lamp which may be obtained from any electrical supplier.

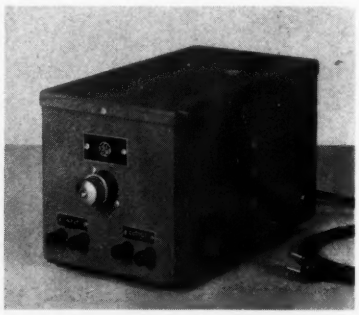
C New Gages. The United States Gage Division, American Machine and Metals, Inc., announces the introduction of a complete new line of streamlined gauges in a modernized design.

The streamlines of the neutral gray case are heightened by a striking ivory-toned dial with contrasting red and black graduations. The company claims long life under adverse conditions for its new group of gages. They are said to have high quality and great durability.



D Self-Balancing Potentiometer Announcement of a new portable self-balancing potentiometer has been made by General Electric's Meter and Instrument Division. Completely self-contained, the new instrument, called an "autopot," is an electric device for converting small d-c voltages to measureable currents without appreciably overloading the measured circuit. Among the services to which the "autopot" may be applied are: telemetering, temperature measurement, analysis of electronic circuits, as a source of constant current, and measurement of unbalance in bridge circuits and the drop across shunts where lead resistance is critical.

Another feature of the self-balancing potentiometer is its flexibility. D-c voltages as low as 10 microvolts and up to 1 v can be measured with any indicating or recording instrument drawing up to 5 milliamperes and having a resistance of 1500 ohms or less. Use of the unit also extends the range of conventional indicating and recording instruments so that they can be



used for high-sensitivity measurement of low d-c voltages and direct currents.

The autopot is completely self-contained. The 5 by 10 by 7¼ in. case houses the bridge elements, power supply, light source, and light-beam galvonometer. Assembled on a welded metal chassis, the unit weighs 5 lb. and is provided with insulated binding posts for input and output connections.

At balance, the current drawn by the input circuit is 0.01 microamperes. Output is 5 milliamperes full-scale for any input range and any output-instrument circuit resistance up to 1500 ohms. Ranges of input voltages are: 100 microvolts d-c full-scale to 1 volt d-c full scale, in decade steps obtained by standardized plug-in-type resistors.

The potentiometer balances to ±1 microvolt; over-all accuracy depends upon the output instrument used. Response time is 1 second on the 200-microvolt range, and less than 1 second on higher ranges.

E Diaphragm Regulating Valves A complete new line of single-seated, fully balanced diaphragm regulating valves for process industries and power plants has been announced by Leslie Co.

These diaphragm valves are made with cast iron, bronze, and steel bodies for steam, air or gas pressures up to 1000 psi, and are designed to be actuated by standard pressure or temperature instruments or controllers using 20 psi air or clean water.

Supplied as standard equipment with 800 Brinell hardened stainless steel main valves and stellited seat rings, these single-seated valves provide equal or greater capacities than most double-seated regulating valves of the same size, and have the additional advantage of being absolutely tight in dead-end service, thereby eliminating leakage of fluid commonly experienced in most

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Fig. 2125
Bronze Gate

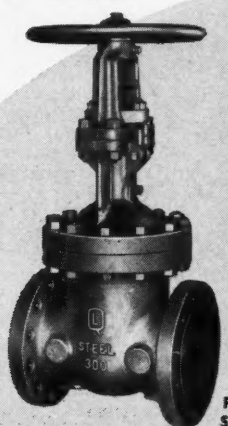

Fig. 1938
Steel Gate

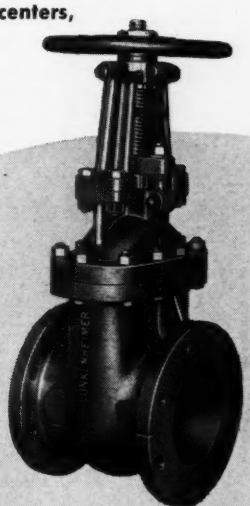

Fig. 1430
Iron Body Gate

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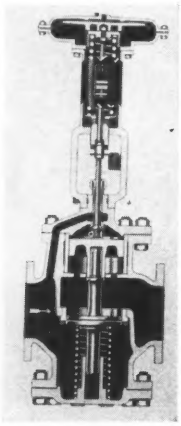
double-seated diaphragm regulating valves when in closed position.

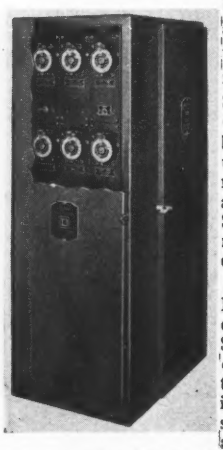
For temperatures over 450 F., steel diaphragm valves are equipped with a newly designed "Conden-Seal" cooling bonnet that offers a large radiating surface, and



the usual feature of a reservoir of condensate to aid in keeping the stuffing box temperature down.

These diaphragm valves, designated as Classes D-1 (cast iron or bronze) and DS-1 (steel) ore normally supplied with the valve below the seat in closed position, opening with diaphragm pressure. However, by use of a new type reversing superstructure, the valve can be easily changed to a normally open below the seat position, closing with diaphragm pressure, without changing internal parts, removing main body from pipe line, or cutting valve stems.

F Combination Welder Control Fully automatic control of air operated resistance welding machines is provided in Square D's new Class 8992 combination control unit, designed to meet recently adopted NEMA Standards for resistance welder control.



A Syncro-Break welder contactor and Safront sequence-weld timer are both included in a single enclosure arranged to mount on the right hand side of the machine with all control elements within easy reach of operator. More convenient adjustment, better appearance, less expensive and more flexible installation, and safer operation are advantages presented by the manufacturer.

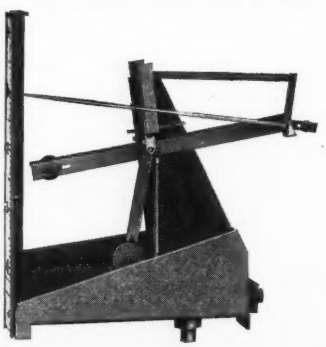
Combination controllers mount on the right hand side of the welding machine, placing the large calibrated dials on the front of the unit within reach of the operator. Minimum time is required for changing any of the several timing periods making up the automatic cycle.

Physical arrangement and dimensions are in accordance with the latest NEMA Standards based on suggestions and requirements of resistance welder manufacturers and machinery users.

Foot switch, pressure switch, no-weld switch and timer control circuits operate at 110 v and are isolated from the power supply to give the operator added safety. A metal barrier between contactor and timer sections of the enclosure eliminates any possibility of flash-over between the power and control circuits.

Combination controllers are designed with a control circuit which may be either separate or common with the power circuit. Solenoid air valve may be energized from either the power or control supply sources by simple reconnection. Standard controllers have tapped primary control transformers which can be connected for operation at 110, 220, or 440 v, 60 cycles; or for 380 v, 50 cycles. Other voltages and frequencies are available on special order.

G Straight Line Draft Gage This recently improved draft gage has new ceramic translucent glass scales, described as straight and everlasting. Another feature is the gages' non-parallax pointer which makes true readings possible regardless of elevation. To expedite diaphragm replacement the movement, diaphragm and scale are assembled in a unit frame which is quickly removable

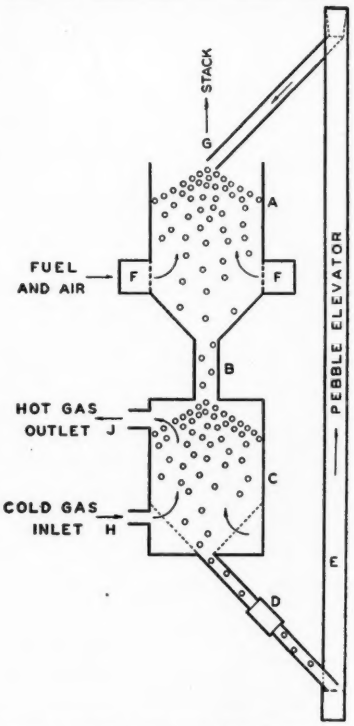


by removing draft gage connection, locknut and front cover. The diaphragm itself is reported to be a high power, free floating unit with a travel of from 8.4 to 17.5 cu. in. at 1 in. pressure. To compensate for a smaller effective area of the diaphragm at the bottom than at the top of the stroke, the pointer arm is set out of true counterbalance made possible by the straight line movement. Diaphragm fabric is made of fine mesh, pure silk cloth. Illumination of the gage is by a standard 15 bulb, 115 v. For 220 v a 25 w bulb is furnished when specified. One light illuminates 5 pointers. Ellison Draft Gage Co.

H New Heat Transfer Unit Development by The Babcock & Wilcox Co. of a new form of heat transfer unit, called the "pebble heater," capable of heating gases above the operating temperatures permissible in metallic heat interchangers, is described here. The principle involved consists of raising to high temperatures a constantly moving column of pebbles made of a heat resistant non-metallic material, and then passing the gas to be heated through the interstices of the moving pebble column.

C. L. Norton, Jr., Technical Director of the company's Refractories Division, said that this unit has been successfully used to heat air to 2300 F. and steam to 1800 F.

"For a long time," Mr. Norton said, "there has been need for a unit that could heat steam to higher temperatures than could be maintained in metallic heaters,



operate at moderate to high pressures, and maintain a uniform non-fluctuating temperature of the heated steam. The pebble heater was developed as a result of these requirements."

"One of the first applications of the pebble heater has been for heating the air used for combustion of fuels," Mr. Norton said. "By using highly preheated air, temperatures can be reached which have been generally considered to belong in the field of electric furnaces, and far exceed the temperatures required for melting steel."

The heater is described as consisting of two cylindrical chambers, one above the other, connected by a throat section of reduced diameter. By filling the chamber and throat with refractory pebbles, permeable beds are formed through which gases can be made to travel. At the outlet of the bottom chamber, there is a mechanical feeder which controls the rate at which the pebbles are conveyed continuously back to the top of the upper chamber. The pebbles in the heater move downward at a constant rate during the entire operation.

Fuel and air are burned in a combustion chamber, and the products of combustion flow through hot gas inlets into the top chamber and then upward through the bed of downwardly moving pellets and out the stack at the top. The heated pebbles pass through the throat section to the lower chamber. At a point near the bottom of the lower chamber, the gas to be heated is introduced. The gases pass through a screen to provide uniform distribution, then travel upwardly through the heated pebble bed and leave at a point near the top of the lower chamber.

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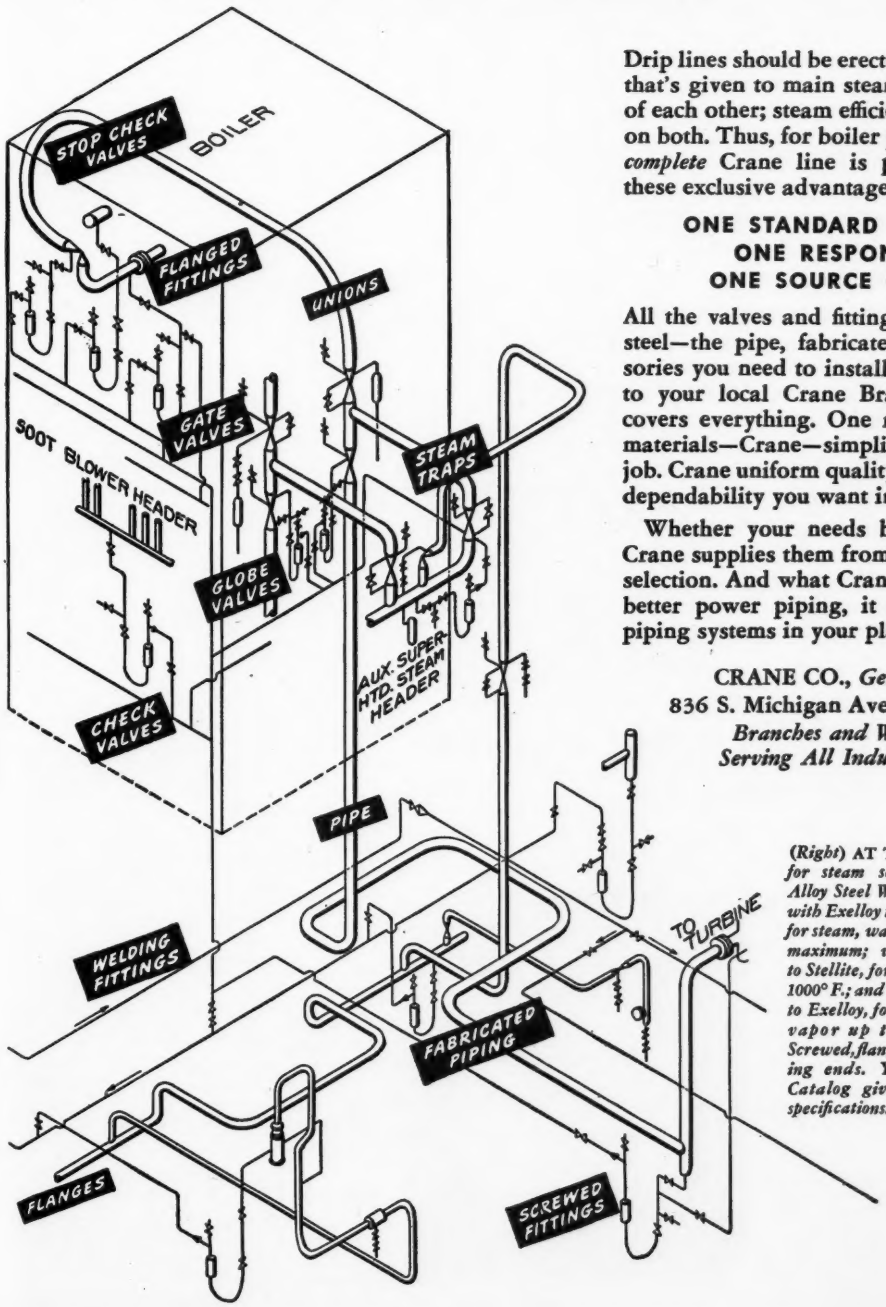

Drip lines should be erected with the same care that's given to main steam lines. They're part of each other; steam efficiency depends equally on both. Thus, for boiler piping especially, the *complete* Crane line is preferred because of these exclusive advantages:

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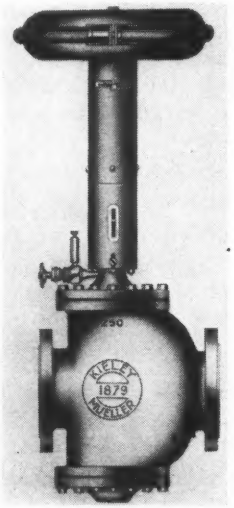
J Diaphragm Valves Announcement is made by Kieley & Mueller, Inc., of a new line of Kontrol Motor Diaphragm Valves for pressure regulators, pump governors, and diaphragm motor control valves.

These valves feature all steel diaphragm motor construction of great strength and light weight. The diaphragm casings are



boltless, assembled with quick acting clamp rings. Diaphragms are molded reinforced neoprene. Unusually large effective diaphragm areas combined with heavy, fully enclosed, heat treated springs, providing maximum power.

Valve position indicators are furnished as standard. Valve bodies are of unusually high capacity, with unrestricted flow areas. Available in bronze, semi-steel, cast steel and special alloys. A wide variety of trim material may be supplied and quick opening, percentage V-port, and parabolic discs may be used. Discs are top and bottom guided and guide surfaces are ground and superfinished to provide minimum friction and maximum life.

K Arc Welder The newest addition to the Hobart "Multi-Range" welder line is a Diesel engine driven arc welder of 300-amp capacity, especially made for use in locations where electric power is not available and a minimum operating cost is desired.

Powered by a two-cylinder, unit-injection Diesel engine, that features oil cooling, displacement blower, fuel filtration and easy starting, this 300 amp welder will cut fuel cost considerably. This engine has a 4½ in. bore and a 5 in. stroke, and is rated 47 hp at 1450 rpm.

Equipped with patented "Multi-Range" dual control and exclusive remote control, this new welder permits the operator to make fine volt-ampere adjustments right at the work, eliminating unnecessary steps from work to machine and back to work. Its 1,000 combinations of voltage and amperage permits the operator to select the right arc intensity to suit any job. Other features of the welding generator includes separate excitation and two-way ventilation, for a smoother, more productive arc at all current values.

The welding generator has a rating of 300 amp at 40 v. Current range for welding duty is from 20 to 40 v, 60 to 375 amp. It is a single operator variable voltage type, with 4 laminated main poles and four interpoles (commutating poles). Pole pieces are removable. This unit also has oversize, 4-pole exciter built in on main shaft that insures quick arc recovery and build up, and eliminates accidental polarity reversal.

The engine controls are conveniently located alongside the generator control cabinet. This panel carries a push button for self-starting, water temperature gage, oil pressure gage, battery ammeter, booster, and pull type control to shut down engine. Engine speed is controlled by a governor and idling device which automatically shuts down the Diesel engine to idling speed 12 to 15 seconds after the operator has stopped welding. To bring the engine to normal welding speed, the operator merely strikes an arc. When welding, the governor controls the engine speed without interference from the idling device.

L Model 40 Controller Describing the Model 40 Controller, The Foxboro Co. points out that it represents no departure in basic operating principles from those of the Model 30, introduced in 1942, but embodies improvements

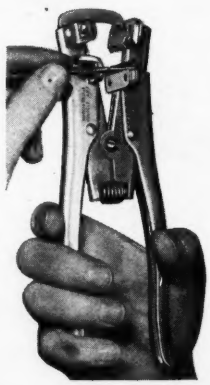
in design and construction. The Model 40 replaces the Model 30 as the Foxboro instrument recommended for control of temperature, pressure, flow and other variables in continuous processes, or others in which control requirements are exacting.

Features of the Model 40 may be generalized as a simplification of design, with more sturdy unit construction, resulting in superior performance, easier and more flexible adjustments, and new convenience in servicing, including the easy replacement or interchange of unit parts.

The operating-panel feature of "Stabilog" control instruments is retained, and when the case door is open every dial, every adjustment knob, and every part normally requiring attention is immediately accessible, without even the need of removing the chart. This advantage is one of particular importance when service adjustments are made in the field.

An outstanding characteristic of the Model 40 is its adaptability in changing from one type of control to another. Setting of the proportional band, from 0 to 200 per cent or higher, is easily made by the turn of a thumb wheel. Reversal of instrument action is made in a like manner. The range of reset is 500 : 1 and, although not considered critical, is a continuous adjustment. Elimination of the reset and derivative functions is extremely simple, when desired. A much-improved adjusting device permits zeroing the pen without realigning the control point. A new-type transfer switch enables the operator to change from manual to automatic control, or vice versa, easily and rapidly and with no valve motion.

M Wire Strippers. This new model automatic wire stripper has just been announced by Holub Industries, Inc. It is said to have been developed to meet a demand for a universal and flexible stripper for electrical workers on construction

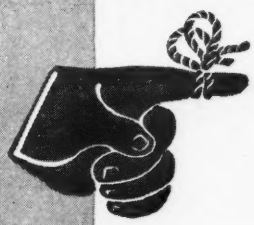


work, plant wiring or production. The tool strips from No. 10 to 22 solid or stranded wire. It clamps the wire, cuts the insulation and strips it—all in one operation. The lever or automatic feature prevents the jamming of wires and strands. Blades are renewable.

N 1947 Unit Heater Line To help engineers and contractors meet the varying requirements of today's complex heating needs, an entirely new postwar line of propeller unit heaters has just been announced by Modine Manufacturing Co. The new line features three distinct types of units with a total of 47 basic capacities. To the conventional horizontal and vertical delivery types there has been added a powerful new, draw-through unit which provides horizontal discharge of heated air over an extra-long range.

Known as the "Power-Throw," this type has specialized applications and may be used alone, or in combination with the

Remember
this trademark



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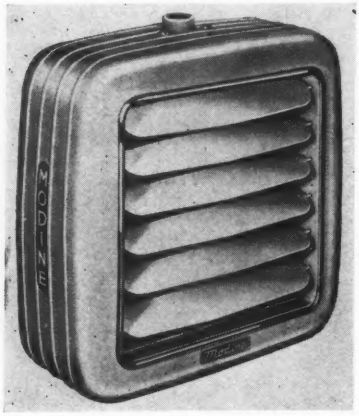


other two types of unit heaters. All three types are available in standard models as well as in models designed to provide low outlet air temperatures when used on steam pressures of 30 lb or more. Models specifically designed for hot water application and for drying and processing jobs are also included in the new line.

In constructional design, the new line of unit heaters incorporate such important improvements as the integral, all-brazed copper condenser. Copper tubes and headers are automatically brazed into rugged, pressure-resisting units under perfectly controlled conditions of time and temperature. Copper fins are mechanically and metallically bonded to tubes. Bends in each tube absorb expansion strains. Casings are acoustically insulated for quiet operation, and are Parker-Bonderized for rust protection before being painted.

O Packless Expansion Joint The MagniLastic Division of Cook Electric Co. announces its new Anchor Joint, latest in its line of packless expansion joints. The Anchor Joint combines rigid anchoring of piping at accessible points, with allowance for unequal thermal expansion and contraction on either side of the anchor point, due to differences in pipe length, ambient temperatures, exposure, etcetera. This is accom-

plished by varying the number of bellows flanges on either side of the anchor base to accommodate each condition encountered. Where severe hydraulic surges within piping occur, Anchor Joints also minimize the transmission of shock to fittings and adjacent structures.

These joints are made for standard pipe sizes from ½ in. to 24 in. The expansion flanges are supplied from any one of the standard MagniLastic 25 lb, 55 lb, 150 lb, 400 lb, or 1000 lb seres, to accommodate all pressures from vacuum to 1000 lb psi. Joints of stainless steel, monel, inconel and copper cover all commonly-met corrosive conditions. Temperatures handled range from—300 F to 1600 F. A variety of standard fittings such as elbows, tees, ells, Y's, etc. can be incorporated into Anchor Joints to make a single, compact, accessible unit. Welding ends, as shown in the accompanying photo ,are regularly supplied, with pipe flanges and inner linings optional.

P Fast-Setting Wood Glue A new cold-run, fast-setting resin wood glue, "Wood-Lok," has been developed for joint assembly operations by National Adhesives.

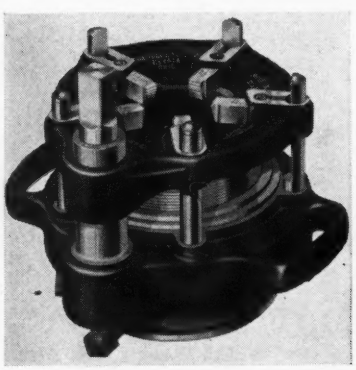
Wood-Lok is the only type of resin glue that can be handled and machined after 20 to 30 min clamping time, instead of the usual six to eight hours. Exhaustive tests in National's laboratories and two years' use and study in a wide variety of wood-working applications in the field, show it produces a strong, resilient bond unaffected by humidity changes.

It is cold-run; therefore, its bonding quality is never weakened by constant heating. It is a liquid, ready for use. Nothing has to be added, soaked or heated. It does not harden in the pot. Its characteristics never change during shipment, application or use. Its storage and working life is months, not three to four hours. Wood-Lok has no odor. It eliminates "chilled" joints; there is no need to heat the glue or wood, or to heat the room above a comfortable working temperature. It never embrittles nor forms a rock-hard abrasive film to dull saws and knives. And its fast setting speed shortens assembly lines and frees working space.

Q Geared Pipe Threader A quick-setting workholder and new balanced loop handles are two innovations on the new 4P geared pipe threader announced by the Ridge Tool Co. The quick-setting workholder affords an advantage in enabling a worker to set the threader exactly to size before being placed on the pipe; once on the pipe only one screw needs to be tightened to hold it securely. All bushings have been eliminated. The balanced loop handles on the enclosed gear case prevent slipping or tipping over, making it easy to pick up and put straight on the pipe, and easy to carry with one hand.

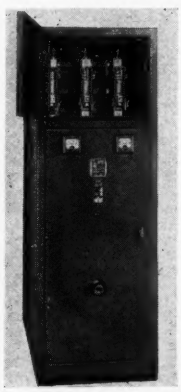
The manufacturer also claims economy of operation by virtue of a twin-anchored drive shaft that turns in oilless bronze bearings. No oil is needed. The gear is fully enclosed, packed in grease, protected from dirt and wear.

Precision made of steel-and-malleable,



the new 4P is provided with four sets of five high-speed steel dies to cut clean, accurate threads, standard or tapered, drip threads and short nipples. A ratchet handle is provided with each 4P and a special design universal drive shaft is available for power drive. Production is said to be still limited, distribution through supply houses only.

R Starters for Electric Motors Electric Machinery Mfg. Co. announces a new line of "Hi-Fuse" polarized field frequency synchronous motor controls with current-limiting fuses. These general-purpose, high-voltage combination starters are suitable for general installation in industrial plants with high voltage service. They are usually applicable without necessity of engineering analysis of short circuit currents, yet provide interrupting capacity generally adequate for all except the largest distribution systems. The "Hi-Fuse" control is a logical complement to the low-voltage combination synchronous motor starters which are universally used, providing (1) disconnecting means, (2) short-circuit protection, and (3) motor overload protection. Furnished in voltage ratings up to 5000, with a current interrupting capacity of 60,000 amp asymmetrical. Enclosures available: NEMA Types 1, 1-A, 5.



S 300 Amp. Solenoid Starter To meet the demand for a larger starter with the solenoid switch structure, Allen-Bradley Co., has developed the Size 5, solenoid starter. This new unit, which has a maximum horsepower rating of 100 hp, 220 v and 200 hp, 440-550-600 v, will replace the older Allen-Bradley, Size 5, clapper starter.

All the features of the smaller Allen-Bradley solenoid starters are incorporated in the new Size 5 solenoid starter. Contact cleaning, filing, or dressing is avoided by the use of cadmium silver contacts. There are no bearings, pivots, or hinges.

The double break, cadmium silver contacts are totally encased in an arc hood, each pole of the switch having its individual arc chamber. Hence, when necessary, these starters can be closely grouped without danger of flash-over between switches.

By employing the solenoid design, the size of the starter has been greatly reduced compared with that of the clapper-type starter which it replaces. At the same time, the wiring space is much increased, and the enclosure is attractively styled. Moreover, the arc-interrupting capacity is high. Currents of at least ten times the maximum horsepower rating are easily interrupted.

The switch has only one moving part. Its construction is very simple and free from complicated mechanisms. Wiring is made easy by plainly marked, accessible terminals and by the ample wiring space between the starter and cabinet. The white enameled interior eliminates dark shadows

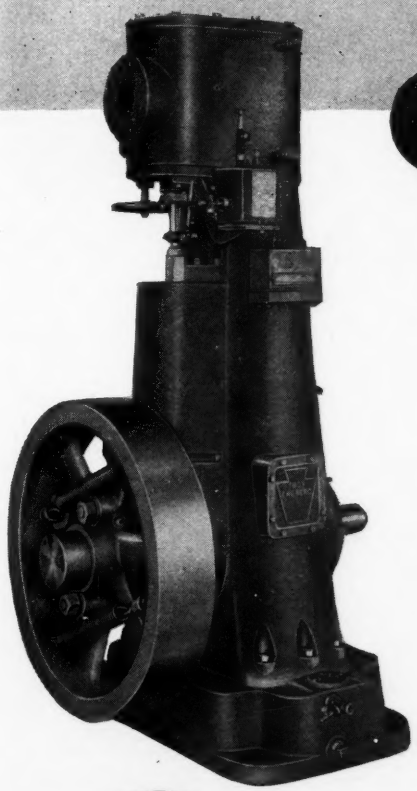
3 LOW COST POWER FEATURES

TROY-ENGBERG STEAM ENGINE

SIMPLE DESIGN

STURDY CONSTRUCTION

CONSERVATIVE SPEED



Thousands of Troy-Engberg Steam Engines have been operating for 10 to 20 years, even longer, without need of major repairs. This contributes to the exceptionally low power cost produced by these engines throughout industry.

Why not investigate the advantages of using the Troy-Engberg Steam Engine in your plant? If you use steam for processing or heating and if you are operating such equipment as compressors, blowers, pumps, stokers, generators, etc... you have the setting for a profitable investment in low cost power.

TROY ENGINE & MACHINE CO.

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Bulletin No. 306 will give you information on the Troy-Engberg Steam Engine. Shall we send you a copy?

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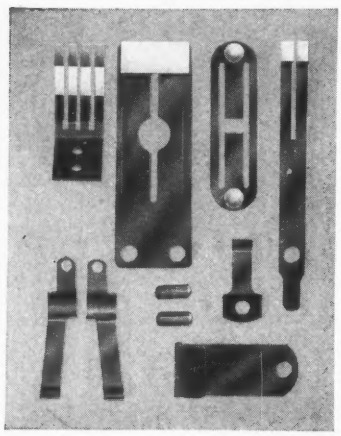
STEAM ENGINES • GENERATING SETS • GENERATORS

and makes terminals and other details stand out distinctly.

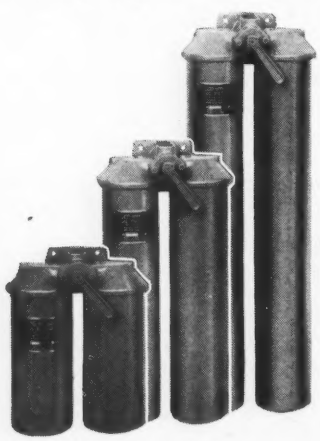
The starter is mounted on a self-insulated metal base plate, which may be mounted on any metal surface without extra insulation. It can be provided with or without an enclosure. The enclosed starter is available in the NEMA Type 1 sheet metal enclosure for general purpose applications, as well as the NEMA Type 4, water-tight and weatherproof; NEMA Type 5, for nonhazardous dust.

T Contact Springs Electrical contact springs of beryllium copper are now being made by the Gibson Electric Co. The new beryllium copper contact springs are recommended for use where exceptional spring properties combined with high electrical conductivity are required. Beryllium copper has a modulus of elasticity of 18,500,000 as compared to



16,800,000 for phosphor bronze and in addition has better fatigue resistance. Its tensile strength, developed by heat treatment, is from 175,000 to 200,000 psi, whereas phosphor bronze has a tensile strength of about 100,000 psi. Its electrical conductivity is 25 to 32 per cent IACS; that of phosphor bronze is 10 per cent IACS.

U Fuel Oil Filters Three new sizes of Hilco Hyflow Duplex Fuel Oil Filters, for bracket mounting to Diesel engines, have been added to The Hilliard Corp.'s line of lubricating and fuel oil filtering equipment. The size units

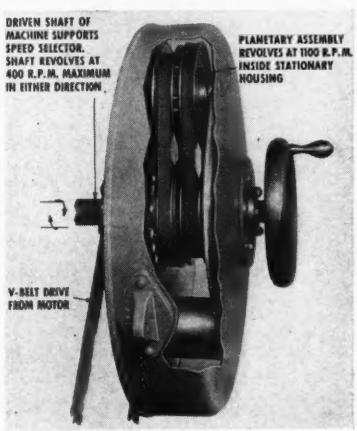


available make it possible to apply these fuel oil filters to engines ranging from 200 hp to 10,000 hp. Duplex operation permits an uninterrupted flow of fuel to the engine . . . by turning the valve control handle, the flow of oil is directed from one side of the filter to the other. A feature built into these units includes made-up type throw-away filter cartridges with gaskets attached, so there are no loose parts. The filtering material is a specially-processed cellulose of very uniform density and so packed as to avoid the possibility of channeling. Filter cartridges are all metal covered to avoid the possibility of migration of any filtering material. These duplex filters are being successfully used for filtering light and heavy fuel oil and they offer micronic filtering.

V Speed Selector A new development of planetary motion in which two standard cross-section V-belts and four variable pitch pulleys provide infinite ratio, stepless speed from full down through zero and into full reverse at constant torque of two-horsepower capacity is jointly announced by Speed Selector, Inc., and The B. F. Goodrich Co.

Speed Selector, Inc., designed and developed the new V-belt control, known as the Variable-V-Planetary Speed Selector, while B. F. Goodrich, will merchandise the product along with its transmission lines.

A slight change in the variable pitch pulleys of the Speed Selector brings a large change in output speed through the multiplying action of the planetary mounted on the motor or driven shaft of the machine


DRIVEN SHAFT OF MACHINE SUPPORTS SPEED SELECTOR. SHAFT REVOLVES AT 400 R.P.M. MAXIMUM IN EITHER DIRECTION
PLANETARY ASSEMBLY REVOLVES AT 1100 R.P.M. INSIDE STATIONARY HOUSING
V-BELT DRIVE FROM MOTOR

on which it is used, eliminating need for special mounting brackets, or extra guards.

In operation the Speed Selector system compares the ratios of two V-belt drives and applies the difference in speed to output shafts. With the ratios equal the difference in speed and output shaft speed is zero. If the ratio of one drive is greater than the other the output shaft rotates forward at a speed proportionate to the difference in ratios. If the ratio is less the output shaft operates in reverse in the same proportionate ratios. Speeds from 400 rpm to zero, forward and reverse can be obtained.

All changes are made by a hand control wheel, which alters the pitch diameter of the center pulleys so that as one is increased the other is decreased and the change imparted to the outer pulleys by the wedging action of the V-belts. It is mounted on the input shaft of the driven machine by a tapered collet. The wheel thus controls diameter of all four pulleys without use of springs or complex linkages.

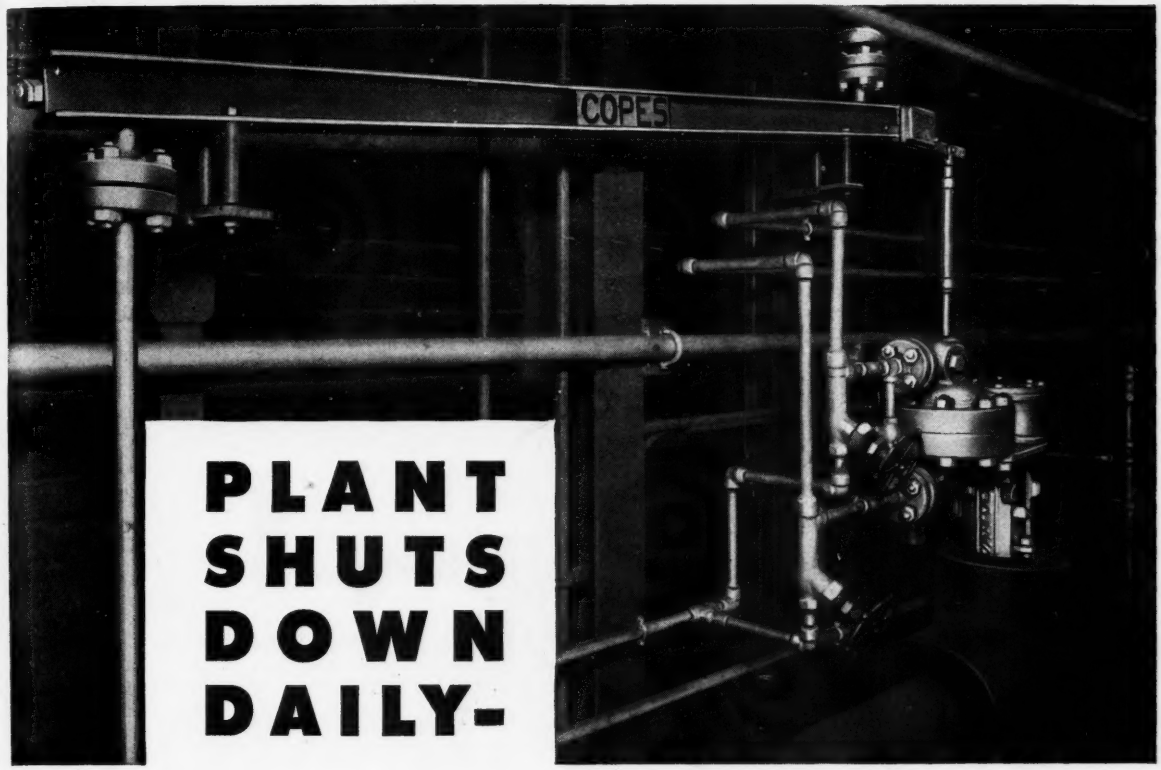
Frame construction of the Variable-V-Planetary is of lightweight aluminum with cast iron sheaves for long wear. Prelubricated, plastic seal, ball type bearings eliminate dirt and lubrication problems. Shafts and other wearing parts are hardened and ground to insure precision fits and long life. Natural ventilation is created by the revolving assembly inside the aluminum housing. The complete speed range is covered by four and one-half turns of the control wheel, with remote controls available.

W Diaphragm Motor for Control Valves Illustrated is Fisher Governor Co. new reverse acting diaphragm motor for control valves, Type 567. On this new top work, the sealing diaphragm construction enables reverse acting without use of a stuffing box. Other features include large diaphragm area; long stroke action; enclosed spring, separate from pressure chamber; linear travel relationship to air pressure change; interchangeable with the company's direct acting Type T Top.

Intended application of this diaphragm

motor is for pneumatic operating control valves where push down to close innner valve construction is desirable, yet operation requires valve air opened, spring closed—closes on operating medium failure.

For field and general service, this top work allows the integral top mounting of Fisher's Wizard Pressure Pilot or Time Cycle Intermitter directly on the valve. Pilot diaphragm assembly of integrally mounted unit is interchangeable with the upper diaphragm casing of this new top work.



PLANT SHUTS DOWN DAILY-

...yet holds high efficiency

CLOSE stabilization of water level is one of the factors permitting this utility plant to operate a Combustion Engineering Type VU boiler at 85-86 percent efficiency, despite an operating cycle which includes dead shutdown for eight to fourteen hours each night. Because of hydro-electric tie-in, the steam station generates only the amount of power required by industrial customers in excess of that available from the hydro system.

Rated capacity of the boiler is 100,000 pounds of steam per hour, peaks of 120,000 pounds per hour being carried for 30 to 45 minutes. During night shutdowns, the only steam generated is that bled through superheater tubes to keep them at proper temperature. Throughout the operating day, water level is held within plus-or-minus one inch by fully-automatic COPES Flowmatic Control.

The story is told in Performance Report Bulletin 455. Write for a copy—on your company letterhead, please.

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Feed Water Regulators, Pump Governors, Differential Valves. Liquid Level Controls, Reducing Valves and Desuperheaters.

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Representatives Everywhere

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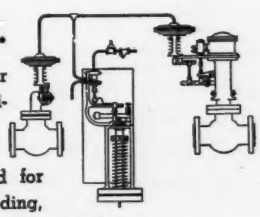
DESUPERHEATER...

Here's a desuperheater every bit as effective on light loads as at full capacity. No water dribbles into the steam line. There is complete atomization of the cooling water from zero to full load because the opening of the spray nozzle—not the pressure drop across it—is varied with steam temperature. A self-contained unit, as *dependable* as the COPES Feed Water Regulator. Write for Bulletin 405-A.

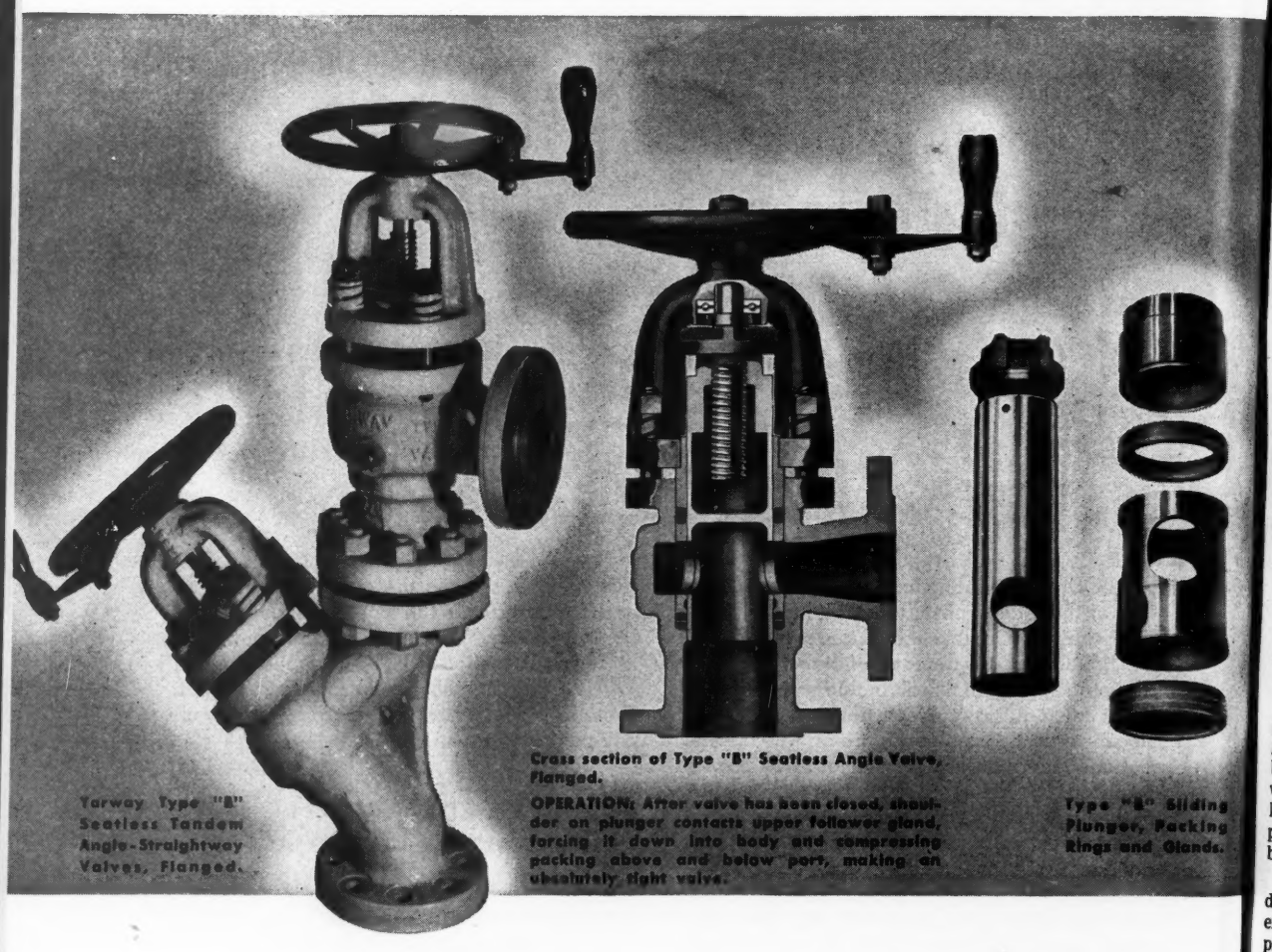
MASTER CONTROL...



Remote control of reduced water or steam pressures, with single or multiple pressure reducing stations, is *dependably* accurate with the COPES Master Control. Adapted for excess pressure control in boiler feeding, where one or more turbine-driven pumps discharge into a common water header. Details on request.

NO SEAT!

TO SCORE...WEAR...CLOG...LEAK



Yarway Type "B" Seatless Tandem Angle-Straightway Valves, Flanged.

Cross section of Type "B" Seatless Angle Valve, Flanged.

OPERATION: After valve has been closed, shoulder on plunger contacts upper follower gland, forcing it down into body and compressing packing above and below port, making an absolutely tight valve.

Type "B" Sliding Plunger, Packing Rings and Glands.

Yarway Seatless Blow-Off Valves have become standard in more than 12,000 boiler plants because they eliminate a common source of trouble and expense with conventional type blow-off valve operation.

Yarways have no seat to score, wear, clog and leak!

This famous seatless design, first introduced by Yarway more than 35 years ago, has been constantly improved and adapted to meet modern service requirements. Mechanical and metallurgical research in Yarway's own unique Steam Laboratory anticipates changing conditions . . . assures the finest in blow-off valves for today's boiler plants.

There is a Yarway Blow-Off Valve for every pressure. For complete details of valves for pressures up to 400 psi., send for Bulletin B-424; for higher pressures ask for Bulletin B-432.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY BLOW-OFF VALVES

WHAT LEADERS SAY—

A Working Philosophy of Human Relations

By DR. SAMUEL NOWELL STEVENS

THE ECONOMY of the United States is rapidly going on the rocks. Even the most wishful thinkers realize that we are face to face with an impending disaster. We are living off our economic fat and are losing weight fast. We have a national debt almost equal to the wisest estimates of our national worth, and more billions are going to be spent, given away and loaned in the near future. Small businesses are breaking down and going to pieces at a rate significantly greater than that in any postwar or peacetime period in our history. New small businesses are dying aborning. Technological advances in all the industrial processes are almost miraculous. Yet all the advances have not yet offset the increased margin of unit cost which is constantly forcing prices up, and choking off ever larger segments of a potential consumer market.

If these trends continue, and it appears that they are likely to, this giant of American power which has been the amazement of the world, will become a disintegrated and helpless weakling, the victim of all the parasites that have grown fat on its blood.

In spite of the vast volume of production which is reported by the Federal Government, a fair sampling of production records for the last month from more than a score of large manufacturing industries producing consumer goods reveals that production is still less than 60 per cent of the 1939-40 basis, in spite of the abnormal increases in real wages which have been negotiated in all of these industries. If, in spite of technological advances, we still have to employ 130 per cent of the people at 50 per cent to 60 per cent greater cost to produce as much per day, as was produced in 1939-40, we can surely observe the way in which industrial anemia will be setting in.

It must be clear to thoughtful people, that our problems are not technological or scientific—they are not even material in nature. Our problems have to do with the attitudes and purposes of men. Technology cannot ruin us, but human nature can. Industrial power cannot destroy us, but human frailty may. Never, in the long history of men's struggle for security and for power, has man been in so much danger from himself, as now. Through intelligence, courage, and a not always too well-placed selfishness, we have created a way of life that has become progressively more complex. The more complex it is, the more inter-dependent our economy and our world becomes. Solutions, if they are to be found, will be located in the resolution of economic conflicts, and in the integration of human problems.

We need a new philosophy of human relations in industry, in Government, and in international affairs. There are fundamental conflicts in economic motives which have gotten us into trouble. We are driven by certain animal instincts, and motivated by certain animal fears. Long processes of social conditioning have overlaid the basic animal tendencies of human nature with a thin veneer of humanity.

Always, there have been men willing to pour their wealth out in a profligate manner to preserve some status quo, or status quo ante, which gave them special privileges in regard to the rest of the human race. The purely acquisitive theory of industry and business, which looked upon labor as a commodity to be bought and sold has, by no means, been abandoned by large groups of business leaders. When men who have been submerged, victimized or disenfranchized socially by men in power become, through organization, powerful themselves, they tend to recapitulate the history of exploitation of which they were the victims.

Unless the controls of society can be specific, definite and strong enough to hold such tendencies in check, the only end that can be expected is a type of warfare in which the very instruments of society are used for the successful achievement of the unsocial ends of the groups engaged in the struggle.

This is the situation with which we are now confronted. The solution to our current social tensions in business and industry is not to be found by a reversion to a more instinctive level of action, which will merely breed further violence, but toward the development of new social controls that will deprive those recently triumphant in their ascendancy over their late enemies, of the opportunities to revert to more primitive forms of revenge.

In addition, through educational processes in management, in labor and in society in general, we must develop a philosophy of human relations which realistically faces the

(Continued on page 113)

Dr. Samuel Nowell Stevens has just completed his fourth year as president of Grinnell College, Grinnell, Iowa. He came from Northwestern University, where he was dean of the University College in downtown Chicago.

He was born at Eastport, Md., in 1900, the son of Philip Thomas Stevens, U. S. N., who commanded the naval experiment station at Annapolis. Graduated from Wesleyan University, Middletown, Conn., he did graduate work at Johns Hopkins, Garrett Institute, and Northwestern, receiving the degrees of B.D. and A.M. in 1923, and that of Ph.D. in 1925. He served in the United States Army during the first World War.

For six years he was president of the Evanston school board. He is a member of the American Association of University Professors, the American Psychology Association, and the Illinois Association of Applied Psychology. He has done research in psycho-technology for national organizations and at present is serving as consultant to Anheuser Busch and Sunnen Products Co. of St. Louis, to Spiegel, Inc., of Chicago, and to the Meredith Publishing Co. in Des Moines. He has been interested in the problems of labor relations for many years, and in the past has served as arbiter for labor disputes and as an advisor on labor relations to both management and labor groups. He is now a public member of the Seventh Regional War Labor Board in Kansas City. He is the author of *A. B. C. of Sales Results, Religion and Life Adjustments, General Psychology,* and has contributed to numerous scientific and psychological journals.

These thought-provoking views on labor management problems are taken from a recent address by Dr. Stevens before the annual convention of the National Confectioners' Association at Chicago.

Corrosion of Plant Equipment by Steam and Water—I

By DR. R.C. ULMER Technical Director, Industrial Department, E. F. Drew & Co., Inc.

CONSIDERABLE CONTROVERSY is taking place regarding the relation, if any, between corrosion and the cleanliness of the heating surfaces of boilers; that is, the amount of scale present. From one viewpoint the presence of a small amount of scale appears to be desirable inasmuch as this thin layer might be expected to protect the metal from corrosion. In fact, there are many plants throughout the country, some of which are quite large, that actually make a practice of forming a small amount of scale on the tubes usually by initially filling the boiler with raw water each time it is drained.

From another viewpoint, removal of the scale appears to be desirable since an alkaline treatment is generally used for this purpose. The increased alkalinity may actually prevent the corrosion. In general it will be found, that where there is good scale prevention treatment, the corrosion problem will be slight or nonexistent.

About the Author

Dr. R. C. Ulmer has had wide and varied experience in the field of chemistry, especially that concerned with power plants. Following the receipt of his AB degree at Ohio State University, he was employed by the Columbus & Southern Ohio Electric Co. in 1930. A Fellowship at Ohio State University was followed by the receipt of his PhD. degree after which he was employed by the Detroit Edison Co. In the Chemical Division of the Research Department of this company he had experience with the diverse problems involved in the operation of power plants. In 1945 the author joined E. F. Drew & Co., Inc., as Technical Director of the Industrial Department. He is at present in charge of all water treating problems and research and development of water treating products for that company.

Dr. Ulmer is the author of many technical papers and holds membership in the following technical and engineering societies. The National American Chemical Society and The Chemists Club of New York, American Society for Testing Materials, American Society of Mechanical Engineers and the National Association of Power Engineers.

The fact that iron is very reactive when in contact with water and steam especially at high temperatures, is not generally recognized. In this respect, metallic iron has a tendency to revert to its natural state, namely the oxide form. If this process is controlled so that it takes place uniformly over the surface, no serious corrosion will occur. The oxide film which forms prevents the metallic iron beneath from coming in contact with the water and consequently no further attack will occur.

In considering the corrosion problem, therefore, the various factors that will prevent this film from forming or that will interfere with its uniformity must be considered in determining the cause for corrosion and in determining means for its prevention the various methods by which this film can be formed and/or maintained in an adherent and uniform condition must be considered.

Types of Corrosion

Corrosion manifests itself in many forms. There are many borderline cases and it is very difficult at times to state just which type of corrosion has taken place. The following types of corrosion are those most commonly encountered.

1. UNIFORM ETCHING OR ATTACK—This type of corrosion usually takes place when the pH is low. The metal is then eaten away in much the same manner as by direct chemical or acid attack.

2. PITTING—This type of corrosion takes place especially when dissolved oxygen is present. It is commonly caused by electrolytic cell action especially of the concentration type. Non-uniformity of the surface is also often a cause of this type of corrosion.

3. GOUGING OR GROOVING—This also as with pitting is a located type of corrosion but instead of round pits being formed the corrosion usually takes place in the form of furrows or gouges.

4. CAVITATION OR EROSION — This type of failure involves actual mechanical disintegration of the metal. Corrosion is not necessary for its occurrence but usually accompanies it. The metal often has a burnished appearance. Corrosion product is seldom if ever present.

5. EMBRITTLEMENT — This type of failure also may be considered as corrosion since it involves a breakdown of protective film by reaction with alkali. This type of corrosion is usually characterized by cracking and under microscopic examination corrosion of the intergranular type can be noticed.

Causes of Corrosion

Before considering the actual causes of corrosion the general aspects of the mechanism of corrosion will be noted. It is a commonly accepted fact that chemical reactions occur at a more rapid rate the higher the temperature. Consequently there will be a greater tendency for iron to corrode to an objectionable extent the higher the steam boiler pressure, that is the temperature. That this reaction may well become serious is evidenced by the fact that serious rusting of iron occurs even at room temperature.

Since iron is so reactive, what must be done is to separate the metallic iron and the water. This can best be done by establishing and maintaining a nonreactive film of iron oxide on the metal surface. This film is not of sufficient thickness to appreciably decrease the heat transfer but if formed uniformly and in such a condition that it will adhere firmly to the metal is very effective in preventing corrosion. This film may be formed by either of the following equations:

1.—$Fe + H_2O = FeO + H_2$

2.—$3Fe + 4H_2O = Fe_3O_4 + 4H_2$

Since the volume of the oxide

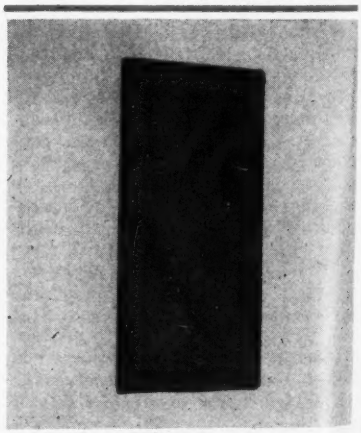


Fig. 1. The sample shown above shows typical general etching or attack

General theory of corrosion that occurs in power plants and particularly in boilers* . . . Characteristics of various types of corrosion . . . Mechanism of corrosion and chemical reactions involved . . . Effects of acid and alkaline solutions . . . How surface condition modifies corrosive attack . . . Effects of metallic deposit on surface . . . Variation in attack due to temperature changes . . . Causes of embrittlement . . . Methods employed for preventing corrosion and embrittlement in modern steam power plants.

formed is greater than the metal itself, the layer or film is very compact and further attack is difficult if not impossible. Once the presence of this film is thoroughly understood and realized then the effect of the various factors in causing corrosion is very easily understood by merely considering the effect of each on the film, especially the tendency to destroy the film. The following are the chief causes of corrosion:

1. Low pH—The pH of the solution may be taken as an indication as to whether or not corrosion is likely to take place. It may be considered as the rate factor. With respect to the film of iron oxide on the surface of the metal, it is now commonly accepted that this film forms to the greatest extent and imperviousness at pH's of 8.5 to 9.0. In general, however, any pH from 7 to 11.5 may be considered satisfactory for operation depending on the temperature and the amount of corrosion, normally, will be quite low unless there is some accelerating factor present. It should be clearly understood that at low pH's the film will dissolve by direct acid attack and that at high pH's the film will dissolve by alkaline attack. At low pH's the equation for the destruction of the film is as follows:

$$FeO + 2HCl = FeCl_2 + H_2O$$

At higher pH's the equation is:

$$FeO + 2NaOH = Fe(ONa)_2 + H_2O$$

The effect of temperature is very important. At room temperature water having a pH of 7 to 9 will corrode very little. In the case of boilers, however, such a water would be very corrosive because of the fact that at higher temperature the rate of corrosion is much more rapid, that is, the metal is much more reactive. Consequently it is necessary to raise the pH to around 10.5 to 11.5. This corresponds to about 20 to 200 ppm of sodium hydroxide. See Table I.

2. Dissolved oxygen—The amount of dissolved oxygen present usually determines how much corrosion actually will occur. According to the electrochemical theory of corrosion when iron is in contact with water some of the iron dissolves and hydrogen plates out of the solution onto the iron. Once the iron becomes covered with a film of hydrogen no more corrosion or solution of the iron will take place. It is here that dissolved oxygen enters the picture in that it reacts with the hydrogen and removes the film thus permitting the iron to come in contact with the water and more to dissolve.

Dissolved oxygen also may influence corrosion in another manner. As stated previously in order for the metal not to corrode it must be covered with a film of iron oxide. Actually a hydrated oxide is usually present. The following reactions may occur:

1. $2Fe(OH)_2 + 1/2O_2 = Fe_2O_3 + 2H_2O$

or

2. $3Fe(OH)_2 + 1/2O_2 = Fe_3O_4 + 3H_2O$

If this attack were uniform no serious corrosion would result. In actual experience, however, the attack is not uniform because (a) the film and metal are not uniform and thus are more reactive in some points, (b) the temperature differences and uneven flow over the surface may influence the rate of attack. Because of this uneven attack, pitting is the usual type of corrosion from dissolved oxygen.

Fig. 2. Pitting on a boiler tube is shown in the above photo

3. Magnesium chloride—This type of corrosion occurs only where high magnesium waters are concerned. As this is usually true only of sea water this type of corrosion is usually found only where sea water is used. As is commonly known the magnesium chloride reacts with water to form hydrochloric acid which in turn destroys the film in much the same manner as low pH (1 above). Magnesium chloride is very serious from the standpoint of corrosion inasmuch as the cycle is regenerative, that is more magnesium chloride is formed and the cycle continues.

4. Nonuniformity of the surface—As mentioned above corrosion usually becomes localized because of some nonuniform condition on the surface. That is, corrosion must start some place and obviously it will start at the weakest point on the surface. In the case of new boilers some mill scale may remain on the tubes and it is possible that a galvanic cell will be set up between the mill scale and the metallic iron. This may be especially serious if cracks are present in the scale inasmuch as the attack will become concentrated on the exposed portion. A deep pit may result. Uneven boiler scale may cause the same difficulty as mentioned for mill scale.

Sludge will have somewhat the same effect as scale inasmuch as if it is not deposited evenly, corrosion cells can be set up between the areas covered with sludge and those free of scale. Also circulation may be cut down appreciably under the sludge deposit and consequently there is a chance for the boiler water to concentrate. This concentrated boiler water, especially the caustic in it, will destroy the protective iron oxide according to the equation given above.

Perhaps of minor importance but at least having some effect on corrosion are the following physical factors:

a. Areas of different heat treatment in the steel. For example, an

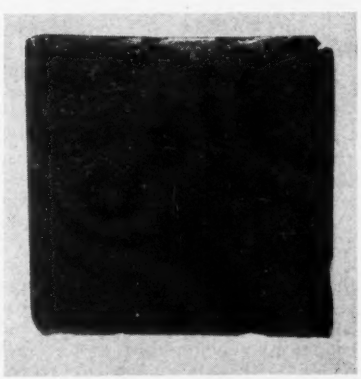


Fig. 3. Pitting is also shown on this piece of boiler feed trough

* This is the first of a series of three articles covering the above subject. The second article will deal with corrosion of feedlines, feed pumps, heaters and economizers. The third article will deal with corrosion of steam lines, superheaters and condensate lines.

annealed portion in contact with cold-rolled portion.

b. Some potential will result between areas having different temperatures and this may be sufficient to cause a breakdown of the cell.

Although in general excellent results may be obtained with certain coatings on boiler heat transfer surfaces, yet some difficulties have been encountered because of the fact that these coatings are not always continuous. If some bare metal is exposed through the coating it is obvious that corrosion will be concentrated at this area. If coatings are to be used it is a good idea to apply them properly and to maintain them in good condition.

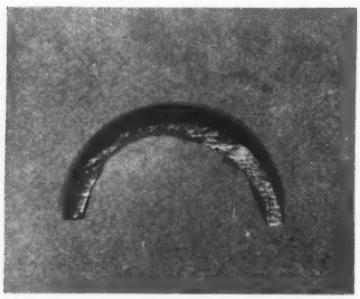


Fig. 4. An example of grooving or gouging is shown in the section above

5. COPPER—There has been much interest in recent years in the effect of copper on boiler failures. As feedwaters have become purer and temperatures higher and higher, there has been greater tendency for solution of brass and copper to take place in the feedwater system. This happens especially in condensers and heaters and other heat exchange equipment. So long as the boiler water is alkaline there is little chance for this copper to deposit as metallic copper. At low pH's and in certain areas where there is poor circulation, however, the copper may deposit and a galvanic cell may be set up between the copper and iron. Very serious corrosion may result in a short time once this occurs. In fact there have been instances where large pits developed in several weeks or months.

In connection with the formation of copper, the acid cleaning of boilers should be mentioned. The acid dissolves the copper oxides which are present in the boiler usually as sludge. Copper in this form will deposit on iron very readily when the solution is acid. In some instances after a boiler has been acid cleaned a continuous coating of copper on the iron surface of the boiler has been found. Calculations have indicated that enormous amounts of copper may be present in any one boiler. Although no serious corrosion has resulted in such boilers, yet this factor should be given careful consideration if boilers are to be acid cleaned, especially since the copper can be removed before the boiler is put back into service.

6. DISSOCIATION—This type of corrosion is normally found only where the metal is at abnormally high temperatures. This may be due to improper boiler design and/or operation. In this respect certain areas of the boiler may have too high a heat transfer rate or there may be poor circulation. Either of these will cause the metal in contact with the water or steam to have a very high temperature. Under this high temperature condition the iron will react directly with the water as follows:

a. $3Fe + 4H_2O = Fe_3O_4 + 4\ H_2$

In this type of corrosion the pH is also important inasmuch as it governs the effect of the film on the iron in preventing contact with the water or steam. Low as well as high pH's cause the breakdown of this film and are objectionable.

7. CAUSTIC EMBRITTLEMENT—There has been much controversy on theories involved and means of prevention of this difficulty. According to the presently accepted information on caustic embrittlement, in order for this type of failure to take place the following conditions must exist:

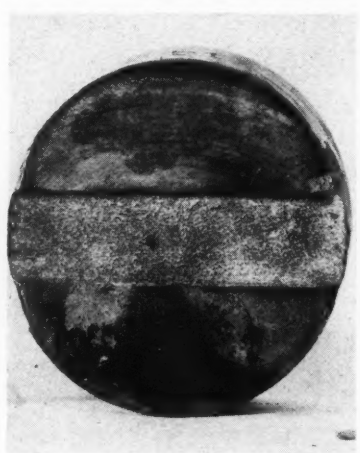


Fig. 5. Cavitation-erosion resulting from high pressure, high velocity flow of water through a slot. Note roughening in the slot

a. Both caustic soda and sodium silicate must be present in the boiler water.

b. These materials must be concentrated to the order of 500 to 1,000 times before caustic embrittlement will take place. About the only manner in which this terrific concentration can take place is through a leak, for example in the riveted parts of older type boilers or around the tube rolls.

c. Boiler metal must be under internal or external stress. By this is meant stress resulting from cold working especially from bending forces such as those used to form the drum or from distortion of metal during riveting and erection. Applied stress resulting from unequal expansion of contraction may be equally important. Stress resulting from operation or design, that is from steam pressure unless localized is not important.

d. What is most important is that all of these conditions must exist at the same time for embrittlement to occur. That is, concentrated boiler water containing sodium silicate and caustic soda must be in contact with the metal when it is stressed.

This problem of caustic embrittlement is rapidly becoming one that has to do only with older types of boilers, inasmuch as newer construction has eliminated most of the possibilities where concentration can take place.

Prevention of Corrosion

In considering the causes of corrosion it should be stressed again that in practically all cases, for corrosion to take place the metal must come in contact with the water or steam. The obvious method for preventing corrosion, therefore, is to prevent the metal from coming in contact with the water or steam. The effort should be directed, therefore, toward the formation and maintenance of a continuous and impervious oxide film on the metal.

pH—As mentioned previous, pH has a tremendous effect on the condition of the film, that is, whether it will prevent corrosion or not. Low pH's dissolve the film by direct acid attack and high pH's have the same effect. Consequently the pH should be controlled so as to insure the minimum solubility of the film and as previously mentioned for boilers this is true when the pH is from 10.5 to 11.5. The formation of this film may be aided by the use of a film type inhibitor, that is, an inhibitor which has a tendency to form an

Table I—Attack of Iron by Water of Different pH's at 590F (1418 psi)
(From data of Berl and Van Taack)

pH	PPM HCl	PPM NaOH	Relative Attack
2	365.0		5.0
3	36.5		3.4
4	3.6		3.0
5	0.4		2.7
7	0	0	2.6
9		0.4	2.5
10		4.0	2.4
12		400.0	2.3
11		40.0	2.3

iron oxide film on the surface. These inhibitors have the advantage that they will prevent corrosion even in the presence of dissolved oxygen. Organic colloids are often used in conjunction with these inhibitors. The colloids have a "plugging" action that makes the film more protective.

DISSOLVED OXYGEN—Also as mentioned above the presence of dissolved oxygen really determines how much corrosion will take place. Consequently the water should be maintained with as low a content as possible of this material. There are two general methods for accomplishing this:

1. Deaeration—Everyone is quite familiar with deaeration at and around the atmospheric boiling point inasmuch as the air is merely boiled out of the solution. In recent years cold water deaeration has been cited and there have been questions in the minds of certain engineers regarding the difference between cold water and hot water deaeration. Actually there is no difference whatsoever inasmuch as in both cases conditions are set up so that the air will boil out of the solution. It is merely more difficult to do this at low temperature than at high temperature. Consequently for sold water deaeration to be effective more emphasis must be put on atomization or breaking up of the water droplets so that the oxygen can escape.

2. Oxygen scavengers—Even though deaeration may be very complete and only a trace of oxygen remains, this small amount of oxygen at high temperatures and pressures may be sufficient to cause serious corrosion. Consequently it is often desirable to remove even this last trace of oxygen. For this purpose a "scavenger" is added to the boiler, or the feedwater is passed over something to remove the oxygen before it enters the boiler. These scavengers are fairly well known, namely sodium sulfite, iron, iron compound, tannins, etc.

USE OF COATINGS, PAINT, ETC.—In general the parts of the boiler that can be coated with such materials are protected from corrosion but unfortunately the corrosion is usually transferred to some other place which usually is more inaccessible than the part where the coating is applied. Unless the entire surface of the boiler can be coated use of these coatings is of questionable value. Also as mentioned above there is danger of holes forming in the coating and corrosion concentrating at these areas. The coating should be maintained in excellent condition if it is to be used at all, otherwise more serious corrosion may result then if the coating is not used.

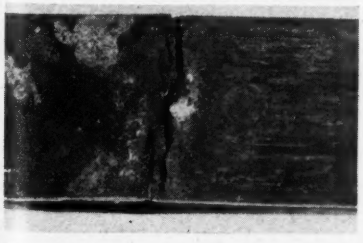


Fig. 6. Typical intergranular corrosion caused by caustic embrittlement

PREVENTION OF ADHERENT SLUDGE—With increased pressures and temperatures more and more attention has been focused on corrosion which takes place because of sludge formation and deposition. It is now realized that straight chemical treatment, that is, merely softening of the water and the formation of the resulting precipitates namely calcium carbonate, calcium phosphate, calcium sulfate, etc., may lead to serious formation of deposits in the boilers, that is, these sludges may adhere even when circulation is considered normal. If circulation is poor, needless to say, deposition may become a very serious factor. In recent years considerable effort has been expended on the development of methods for maintaining this sludge in a fluid condition or at least for preventing its adherence to the boiler metal. In general these methods have involved two principles:

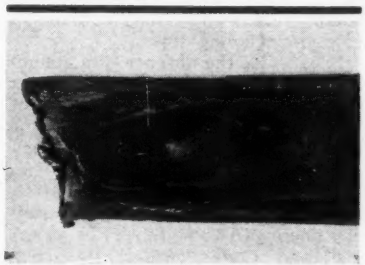


Fig. 7. This shows a pit in a boiler tube. The shiny material is copper around the pit

a. The use of a coagulant.
b. Use of a dispersing agent.

Both methods have appeared to prevent deposition in certain instances. Since sludge may contribute greatly to carryover, however, it would appear that coagulation by which the sludge content is decreased is to be preferred to dispersing. This statement is based upon the fact that as the sludge is coagulated it will settle out into the lower portions of the boiler where it can be blown out. If a dispersing agent is used, the sludge remains throughout the boiler and serious carryover may result. This leads to excessive blowdown to maintain the solids at such a low concentration that no carryover will result.

With respect to developments along the line of coagulation, in recent years these have been mostly of an organic and also of a colloidal nature. These materials are sufficiently stable to be used at high temperatures and pressures.

PROPER DESIGN—Under this heading also should come proper operation, inasmuch as many boilers are designed properly but not operated properly. Improper water level may lead to overheating of tubes and excessive corrosion from overheating. Also in recent years a lot of attention has been focused on design of boilers from the standpoint of the elimination of poor circulation and overheating. To determine when this is occurring or especially when the metal is reacting directly with the water or steam by dissociation, hydrogen tests are usually made on the steam.

Fig. 8. An exceedingly bad case of scale. This may lead to overheating and reaction of water and steam with the tube metal

These tests may be conducted in a variety of manners depending upon the accuracy and the continuity of the record required. For example, the steam may be condensed and passed through a bubbling tower where the hydrogen can be collected. If this method is used tests should be made to determine whether the gas collected is actually hydrogen as considerable nitrogen may be present in the water also.

If a continuous record is desired hydrogen recorders are now available that will give the amount of hydrogen present in the steam and water. If such a recorder is available conditions can be varied in the boiler especially with respect to boiler water treatment so as to obtain a minimum amount of hydrogen in the steam. Under this condition the minimum amount of corrosion will be taking place.

In many boilers the feedwater is added near the bottom of the boiler. This permits the oxygen to react throughout the boiler. Far better results are obtained if the feedwater is added near the top of the boiler when the oxygen passes off with the steam.

PREVENTION OF EMBRITTLEMENT—Before taking serious steps to treat the water to prevent embrittlement

(Continued on page 91)

Power Plant Services for 3 New G-M Assembly Plants

By **F. L. EINBERGER** Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

Power, steam and compressed air service for the Buick, Oldsmobile and Pontiac assembly plants now being built by General Motors Corp. at Atlanta, Ga., Framingham, Mass. and Wilmington, Del. . . . At all three, pumping and storing industrial liquids an important problem . . . No steam generating plant needed at Atlanta; heating by natural-gas-fired space heaters . . . Cooling tower for air compressor cooling water . . . At Framingham and Wilmington, three 60,000-lb-per-hr, 150-psi oil-fired boilers generate steam . . . Combination of motor-driven and steam-driven auxiliaries and air compressors gives operating flexibility . . . All exhaust steam at 10 psi used for space, oil and feed heating

BECAUSE of the increased demand for automobiles, three General Motors Assembly Plants are now under construction in various parts of the country. These plants located in Framingham, Massachusetts, Wilmington, Delaware and Atlanta, Georgia will, in the near future, be assembling Buicks, Oldsmobiles, and Pontiacs to satisfy the great demand built up during the war years and the anticipated market needs of the future.

The boiler and compressor houses for the above mentioned plants are of steel and brick construction of modern design. Their outward appearance blends in with the general architectural style of the main assembly buildings and other auxiliary buildings. Plenty of window area will assure good lighting and ventilation. Quarry tile is to be used on the operating floors for cleanliness and ease of cleaning. The boiler houses at Framingham and Wilmington are so designed that they can be readily converted from oil-burning to coal-burning plants or additional steam generating equipment installed by extending the buildings.

Design of Atlanta Plant

The power facilities at the Atlanta plant differ somewhat from those at Wilmington and Framingham because of the milder Southern climate. It was found economically feasible to use individual natural-gas-fired space heaters at the Atlanta plant rather than steam heaters, thus eliminating the need of a central heating plant. Therefore, in place of the usual boiler house, there is a compressor and pump house, which also contains a 1300-gpm cooling tower.

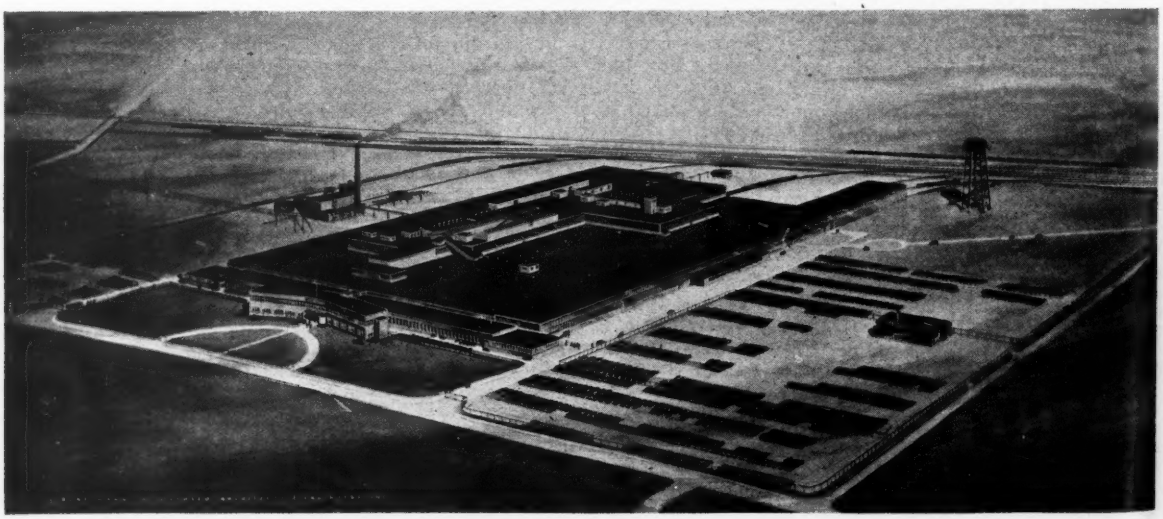
Because of the absence of a steam-generating plant, the air compressors are motor driven. The compressor room contains three 1350-cfm and one 250-cfm motor-driven air compressors. Each air compressor has individual air tanks and filter, aftercooler and air receiver; this permits any one or all to be in service at any one time. Cooling water to air-compressor jackets, intercoolers and aftercoolers is supplied by a centrifugal pump from the cooling tower through a closed piping system. Compressed air at 100 psi is brought over to the factory by an overhead line.

Cooling Tower

An induced draft cooling tower is located on the roof of the compressor room. It has a cooling capacity of 1300 gpm of water from an inlet temperature of 100 F to an outlet temperature of 81 F, based on a wet bulb temperature of 75 F. The tower is divided into three sections: one 300-gpm and two 500-gpm sections.

The 300-gpm section is used for cooling water for the air compressors while the two 500-gpm sections will furnish cooling water to the electric welding machines in the assembly building, the farthest point served being some 800 ft away. Two 500-gpm motor-driven centrifugal pumps furnish water to the welding ma-

Fig. 1. General architects' perspective drawing of complete General Motors BOP assembly plant at Wilmington, Del. Power plant at upper left



chines at 40 psi through a closed piping system. On the welding water return line in the compressor house is located a 1000 gpm motor driven centrifugal pump for returning the water to the cooling tower. This is shown in the cooling tower piping diagram, Fig 4.

Pumping and Storing Industrial Liquids

The pump room, which is a part of the compressor house, contains seven pumping units. These units will all be motor-driven, 25-gpm gear pumps for handling the following liquids:

1. Rear axle
2. Transmission lube
3. Motor oil
4. Paint thinner
5. Spirits
6. Anti-freeze
7. Gasoline

The tank farm consisting of seven 12,000-gallon steel storage tanks, for storing the above mentioned liquids, is located near the compressor and pump house. All tanks are horizontal, above ground and enclosed by a concrete retaining wall. Tanks for storing the viscous liquids are equipped with heating coils. All the industrial liquids will be brought in by tank cars.

By a system of manifolding at the pumps, each pump will be used to unload a specific liquid from the tank car to its respective storage tank, as well as to pump from the storage tank to various points for use in the assembly building. All pipe lines from pumps to assembly building are run overhead on a trestle along with the compressed air line.

Boiler Houses at Wilmington and Framingham Similar

The boiler houses at Wilmington and Framingham are similar in size and layout, although the makes of equipment installed at each plant differ somewhat. The major difference in design is that, at Wilmington, a radial brick stack produces natural draft for the boilers, while at Framingham induced draft fans with stub stacks supply the required draft.

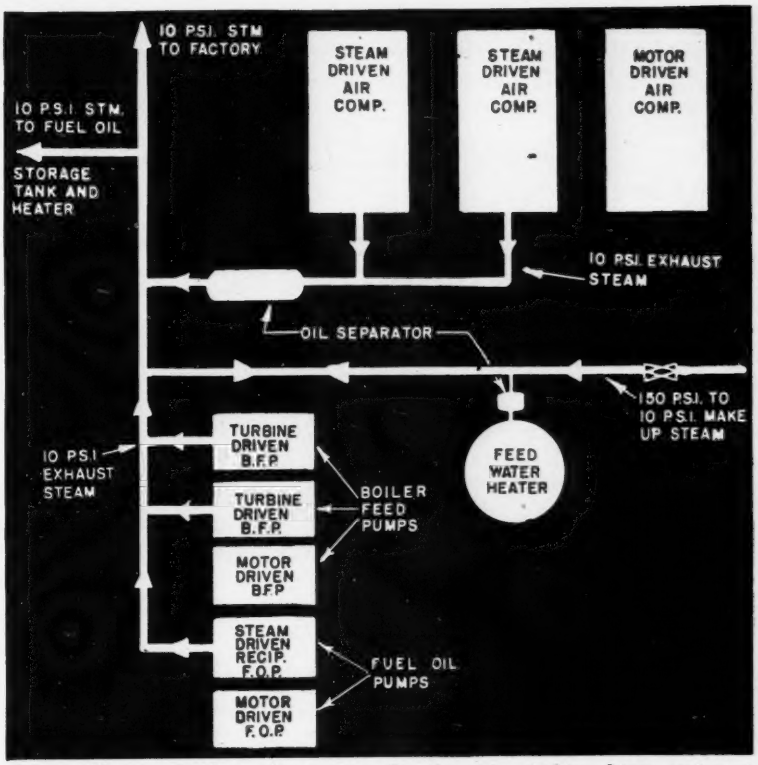


Fig. 2. Diagram showing exhaust steam flow from steam-turbine driven equipment, Framingham and Wilmington power plants

Therefore, a description of the Framingham plant will also describe the Wilmington boiler house.

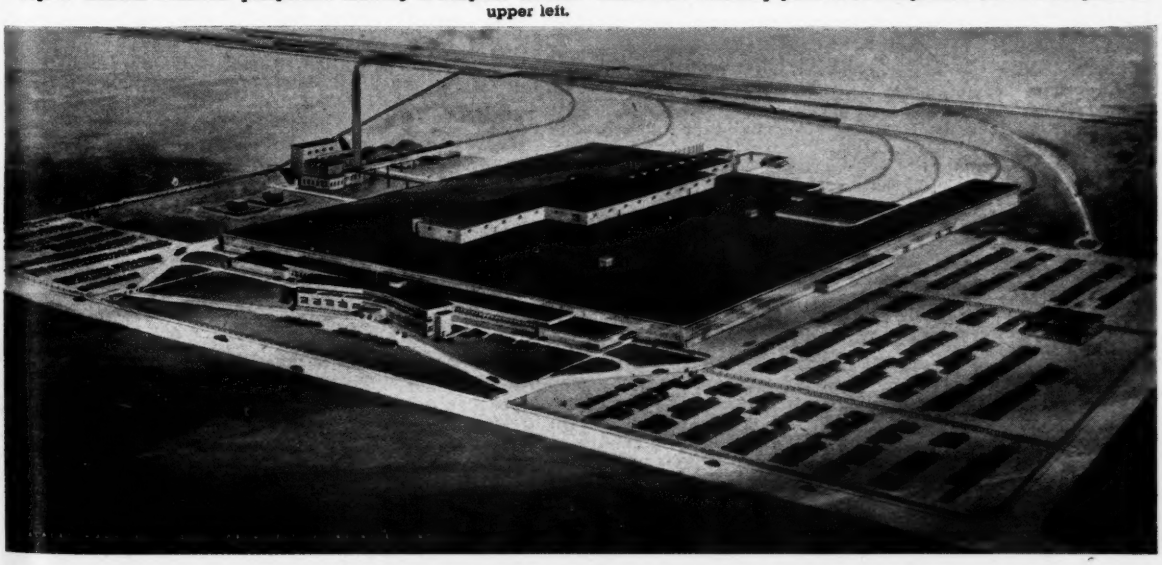
Steam generating equipment consists of three 60,000-lb-per-hr water-tube boilers, oil-fired, with an operating pressure of 150 psi. Other auxiliary operating equipment in the boiler house consists of motor and turbine-driven boiler feed pumps, fuel oil pumps, forced and induced-draft fans, motor and steam-driven air compressors and a 180,000-lb-per-hr, open-type feedwater heater operating on a 10 psi back pressure.

The nature of the steam load is such that all exhaust steam (10 psi) from auxiliary equipment in the boiler house can be used for heating in the factory or utilized in the boiler house in the feedwater heater or for heating fuel oil. All steam-operated pumps, compressors and turbines operate on 10 psi back pressure.

How Flexibility Is Obtained

Flexibility in operating economy is obtained by employing both steam and motor-driven equipment. Since a large part of the connected load is used for heating at 10 psi during the

Fig. 3. General architects' perspective drawing of complete General Motors BOP assembly plant at Framingham, Mass. Power plant at upper left.



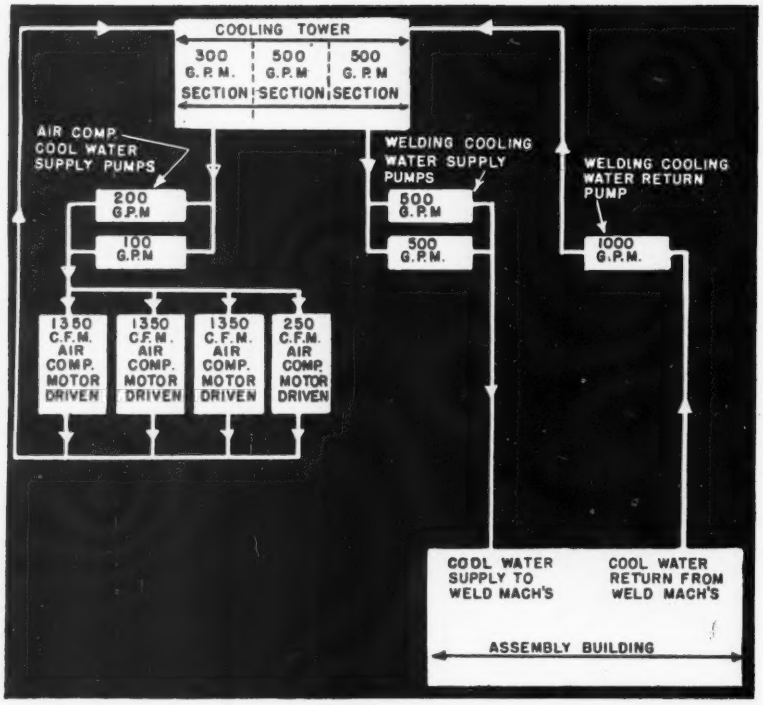


Fig. 4. Piping diagram for cooling tower at Atlanta

List of Principal Power Plant Equipment at Atlanta, Framingham, Wilmington Assembly Plants, General Motors Corp., Buick-Oldsmobile-Pontiac Division

ATLANTA

Compressors and Aftercoolers	3—Chicago Pneumatic Tool Co. 1—Ingersoll-Rand Co.
Industrial Liquid Pumps	Viking Pump Co.
Industrial Liquid Storage Tanks	Graver Tank & Mfg. Co.
Cooling Tower	Lilie-Hoffman Cooling Towers, Inc.
Cooling Tower Pumps	Ingersoll-Rand Co.

FRAMINGHAM

Boilers	Combustion Engineering Co.
Boiler Feed Pumps	Worthington Pump & Machinery Corp.
Feedwater Heater	Worthington Pump & Machinery Corp.
Forced and Induced Draft Fans	The Green Fuel Economizer Co., Inc.
Turbines	Elliott Co.
Boiler Meters and Controls	Bailey Meter Co.
Oil Burners	Peabody Engineering Corp.
Compressors and Aftercoolers	Worthington Pump & Machinery Corp.
Industrial Liquid Pumps	Viking Pump Co.
Industrial Liquid Storage Tanks	Graver Tank & Mfg. Co.
Fuel Oil Pumps and Heaters	Worthington Pump & Machinery Corp. Warren Steam Pump Co.
Feedwater Regulators	Northern Equipment Co.
Sootblowers (Air-puff, Automatic)	Diamond Power Specialty Corp.

WILMINGTON

Boilers	The Babcock & Wilcox Co.
Boiler Feed Pumps	Allis-Chalmers Mfg. Co.
Feedwater Heater	Hoppes Mfg. Co.
Forced Draft Fans	Clarage Fan Co.
Turbines	D. E. Whiton Machine Co.
Boiler Meters and Controls	Bailey Meter Co.
Oil Burners	The Babcock & Wilcox Co.
Compressors and Aftercoolers	Ingersoll-Rand Co.
Industrial Liquid Pumps	Geo. D. Roper Corp.
Industrial Liquid Storage Tanks	Graver Tank & Mfg. Co.
Fuel Oil Pumps and Heaters	Worthington Pump & Machinery Corp.
Boiler Feedwater Regulators	Northern Equipment Co.
Sootblowers	Diamond Power Specialty Co.

winter only, some motor-driven equipment in the boiler house was required for summer operation. This set-up permits all steam or any combination of steam and motor driven auxiliary equipment to be used, the exact combination to be determined by the steam demand. See Fig. 3.

The largest supply of exhaust steam comes from the two steam-driven air compressors. These compressors exhaust approximately 10,000 lbs of steam per hour each at 10 psi, which is used for heating in the factory and boiler house during the heating season. In the summer, one steam-driven compressor will be run in conjunction with the motor-driven compressor, the exhaust steam being utilized in the feedwater and fuel oil heaters. As at the Atlanta plant, each compressor has separate air intake and filter, aftercooler and receiver.

Cooling water for compressors will be obtained from the factory welding-machine cooling water discharge. In place of the welding machines discharging their cooling water to waste, it is pumped through the compressors and aftercoolers before being discharged to waste.

Fuel oil (Bunker "C") is received in tank cars and unloaded by pump. Large vertical, steel storage tanks, above ground, (one-640,000-gal tank at Framingham and two 250,000-gal tanks at Wilmington) will assure ample fuel oil supply. The fuel oil is pumped to the oil burners at a pressure of approximately 200 psi and a temperature of 200 F.

Efficient combustion is obtained by automatic combustion controls. These controls maintain the correct fuel-air ratio, and regulate the forced and induced draft fans, with steam pressure as the activating medium.

Along with the combusion controls, recording steam flow meters, feedwater and flue gas temperature recorders and draft indicators will enable the operating crew to run the plant safely and efficiently.

Boiler water concentration is controlled by means of a continuous blow-down system. The blow-down is run through a flash tank and then through a heat exchanger. Any flash steam is piped back to the feedwater heater. Make-up water to the boilers is first put through the heat exchanger for preheating before going to the feedwater heater. Since the boiler makeup water is approximately 25 per cent of the steam output, a substantial saving is obtained by the use of a continuous blow-down system. Chemical treatment is injected into the boiler feedwater line on the discharge side of the boiler feed pumps.

Methods of storing and handling industrial liquids are similar to those at the Atlanta plant.

Outages Reduced by Banked Secondary Operation of Transformers

By **ST. GEORGE TUCKER ARNOLD** Engineering Department, Boston Edison Co., Boston, Mass.

Use of transformers with self-contained circuit breakers on a banked secondary circuit not only reduces outages but also results in decreased investment. Banked operation also improves general voltage level . . . Decreased investment brought about because less transformer capacity necessary in banked arrangement than in radial . . . Increased system peak loss in banked scheme due to heavy overload . . . Transformers loaded to 170 per cent capacity

FOR TWO YEARS the Boston Edison Co. has had in operation in one of its suburban residential towns an experimental bank of four Westinghouse, 10 kva., single-phase, 2-breaker, CSP type transformers.

During this time, the operation has been without incident. There have been no openings of either the "main" or the "section" breakers and no primary protective links have blown.

Figure 1 shows the original primary and secondary layout with radial secondary distribution. The secondary mains are 3 No. 4 or 3 No. 2 in size with a few sections of 2 No. 1/0 and 1 No. 2. The approximate locations of the houses are indicated, and the letter "R" denotes an electric range customer. Of the 70 customers served, 50 have electric ranges. The area was served by three 25 kva, single-phase transformers and by one half of the capacity of a 15 kva transformer. This capacity, 82½ kva, had a maximum winter demand of 69 kva and a summer demand of 55 kva.

Figure 2 shows the bank of four 10 kva, 2-breaker, CSP transformers. To establish this bank, it was necessary to install only one 115-foot section of 3 No. 4 secondaries. Note that the secondaries form a complete ring, a desirable feature for the 2-breaker transformer bank.

The locations of the transformers were carefully selected from a study of the loads on the four transformers in the radial setup and with due consideration to the location of range customers. The peak loads on the four 10 kva transformers during the Christmas week of 1943 were 16, 15, 19, and 18 kva, a total of 68 kva. The loads indicate that the choice of locations were satisfactory.

Figure 3 shows the winter weekday load cycle for B-phase of the primary circuit. The 68 kva within the area being considered constitutes one third of the load on B-phase. An analysis of the daily load cycle at four seasons of the year indicates an annual yearly copper-loss factor of 17.3 per cent.

The comparisons as shown in Table I are interesting. These indicate that there is 42½ kva less transformer capacity in the banked scheme than in the radial. This is a significant saving in transformer investment. The banked transformers are loaded in the neighborhood of 170 per cent of rated capacity during the winter peak of about two hours' duration. For a load of this type, the overloading of the transformer to 170 per cent of the name plate capacity is an economical practice provided the voltage supplied to the "end" customers remains satisfactory. The banked operation improves the general level of the voltage.

The banked scheme has 0.797 kw more system peak loss than the radial which must be evaluated against the saving in transformer investment. This increase in loss is due to the heavy overload on the transformers. The annual kilowatt losses are nearly equal for the two schemes notwithstanding the fact that the transformer capacity in the banked-secondary connection has been reduced over 50 per cent.

Recording voltage charts for a 24-hour period were taken at six locations in the area when the distribution was radial and when it was banked. The charts show essentially the same average voltage for the two methods. The voltage improvement effected by banking the secondaries

Fig. 1. The area selected for the banking experiment contained mostly the residential-type load with an unusually large percentage of electric ranges. Secondary distribution was radial

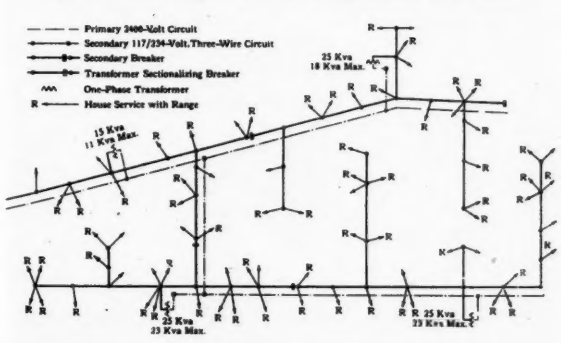
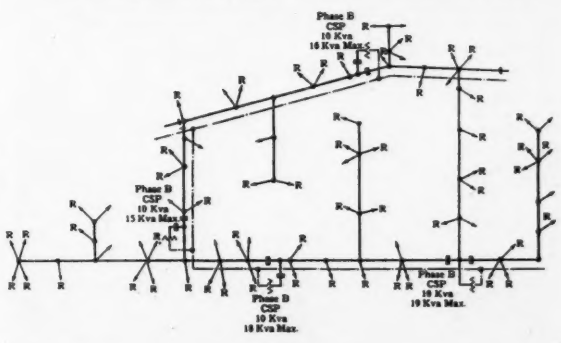


Fig. 2. The same area as shown in Fig. 1 has been converted to banked secondary distribution using CSPB transformers with sectionalizing breakers integral within the transformer tanks



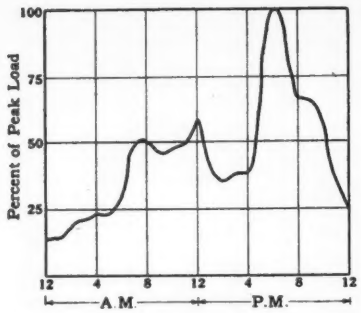


Fig. 3. Range and lighting loads combine on a late afternoon in winter to produce a typical short-time peak demand on the particular phase of the primary feeder supplying the experimental bank. Because the peak is of such short duration, the bank can be loaded considerably over its rated capacity

was about equally offset by the additional drop in the overloaded transformers.

The chief objection to banking single-phase transformers is the possibility of the transformers "cascading" in case of a sustained secondary short circuit or severe overload. The 2-breaker CSP transformers have features that make them less liable to "cascade" than the 1-breaker CSP transformers or the conventional transformers with secondary fuses. This will be illustrated by outlining the operation of the transformers in event of three typical disturbances.

In the event of a sustained short circuit on the secondary main, there will be three breaker operations: first, the "section" breaker opens on one transformer; next, a "section" breaker opens on the adjacent transformer; and lastly, the "main" breaker opens on the transformer that is feeding into the fault. The faulted main will be cleared. Unfortunately, however, one transformer will be disconnected from its entire secondary load by the opening of the "main" breaker.[1]

In the event of extreme overload on one or a group of 2-breaker transformers, the overloaded transformers will protect themselves by the opening of their "section" breakers, transferring a part of their load to adjacent transformers. If the adjacent transformers are capable of handling this load, the operation will be stabilized at this point. If not, their "section" breakers will open and the entire bank may revert to radial distribution and in the event that any transformer has excessive load, the "main" breaker will open and the load will be dropped. An unfortunate feature of this operation is that the exact location of the excessive load is not positively determined by the breaker operations. Load tests would have to be made to determine the proper place to install additional transformer capacity.

In the event of a short circuit in the transformer winding, the faulty transformer would be cleared from the secondary system by the operation of the "section" and the "main" breaker and would be cleared from the primary by opening of the protective link.

An objection expressed by the operating people to the 2-breaker transformer is the difficulty of giving the trouble-men simple enough instructions for the operation of the bank for the breaker openings that might take place for the several types of trouble or for overload.

The writer is of the opinion that the 2-breaker transformer would be better adapted to banking if each of the two secondary breakers were a "section" breaker and design features could be incorporated so that in the event of overheating of the transformer the "section" breaker that is

(*Continued on page 91*)

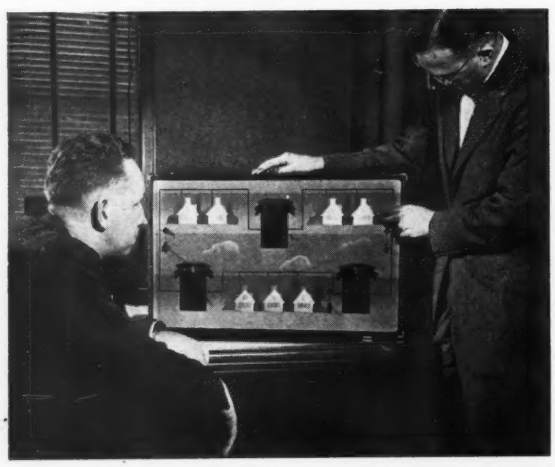
Table I. Comparisons indicate there is less capacity in the banked scheme than in the radial

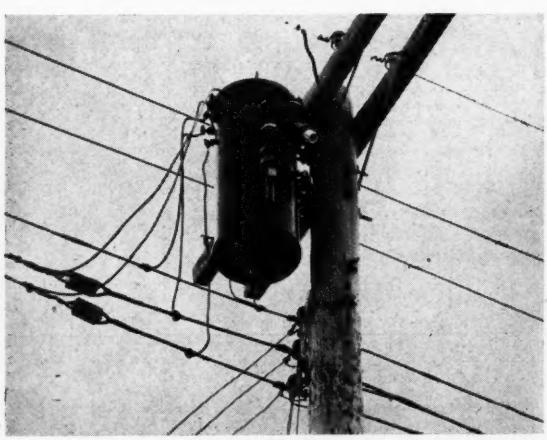
		Radial Secondary Distribution	Banked Distribution Special Westinghouse 2-Breaker Transformers
Total No. Customers		70	70
Total No. Ranges		50	50
Transformer Name Plate Kva		82.5 Kva	40.0 Kva
Transformer Name Plate per Customer		1.180 Kva	0.572 Kva
Winter Peak Kva		69 Kva	68 Kva
Peak Load on Transformer		84%	170%
Peak Losses Kilowatts	Trans. Core	0.380 Kw	0.248 Kw
	Trans. Copper	0.932 Kw	1.961 Kw
	Sec. Copper	0.525 Kw	0.425 Kw
Total Losses		1.837 Kw	2.634 Kw
Annual Energy Losses	Trans. Core	3,300 Kwhr	2,170 Kwhr
	Trans. Copper	1,400 Kwhr	2,970 Kwhr
	Sec. Copper	,800 Kwhr	,645 Kwhr
Total Losses		5,500 Kwhr	5,785 Kwhr

[1] Subsequent changes in design since these experimental units were installed have eliminated these objections.

Fig. 4. (Left) This demonstration model shows the use of a banked secondary system in which the new Westinghouse completely self-protected transformer for banking (CSPB) is employed. A loop type secondary system is illustrated in which three transformers are used and seven houses are fed from the bank. A fault can be applied by either one of the three switches located in the sections between transformers. The signal lamp above the switch indicates a fault when lighted and as the sectionalizing circuit breaker trips, the signal lamp above it lights up thereby identifying the breaker that is open

Fig. 5 (Right) View of a CSPB transformer installed on pole





How the Springdale 80,000-kw Turbine Is Built

New steam turbine generator unit No. 7, recently installed at Springdale Power Station of West Penn Power Co. is one of largest 3600-rpm machines to be installed up to present time . . . It is a Westinghouse unit; entire station was described in July 1946 issue, Power Plant Engineering . . . Turbine is a two-cylinder, tandem-compound, double-flow, impulse-reaction-type unit; normal rating 65,000 kw; full load rating 81,250 kw at 1250 psig, 925 F, 1.5 in. Hg, 3600 rpm . . . Details of heat balance, control valves, blading, bearings, expansion provisions . . . Hydraulic governor . . . Condenser details . . . Vertical condensate pump construction

THE HEAT BALANCE diagram for the complete new No. 7 unit at Springdale Power Station is shown in Fig. 5. The turbine is provided with four extraction points for feed-water heating located between 11th and 12th and between the 18th and 19th stages of the high pressure turbine, at the cross-over connection between the high and low pressure turbine and between the 4th and 5th stages of both halves of the low pressure turbine.

The three highest-pressure bleed points are equipped with motor-operated Thrustor check valves, which close on reverse flow. The low pressure bleed point is equipped with a motor-operated gate valve. All valves close when the throttle valves trip and when high water is experienced in heaters.

Two 10-in. throttle valves with integral steam strainers control the supply of steam to the high-pressure turbine. Each throttle valve is located on one end of the steam chest. This arrangement was selected in order to make possible the complete closing of one throttle valve to check for throttle valve stem sticking while the unit is in operation.

The high pressure element, shown in Fig. 6, consists of a heavy duty two-row impulse wheel, constructed as in Fig. 1, followed by twenty-two pairs of reaction blades. All cylinder blading is carried in separate blade rings. In addition, the dummy ring is separate and all blade rings and the dummy ring are supported at the centerline to minimize distortion.

The high pressure element is designed with an internal by-pass which is arranged to open at loads above 65,000 kw. By the use of this internal by-pass construction, the first stage pressure and temperature are limited to a maximum of 665 psig and 780 F.

The steam flows through a 42-in. cross-over pipe, Fig. 6 (see also Fig. 3, page 113, July issue) and into the center of a double-flow low-pressure turbine consisting of seven pairs of reaction blading on each end. The low pressure turbine is equipped with water catchers ahead of each of the last three stages. The last three rotating rows on each end of the double-flow low-pressure turbine are protected by single piece, renewable, stellite erosion shields. The last row of blades, Fig. 3, has integrally forged lashing wire stubs which are joined together in groups having natural frequency removed from the running frequency. These blades are of the side-entry type, fastened by a buttress thread on a separate rotating disc shrunk and keyed on the low-pressure rotor.

Bearings and Expansion Provisions

The high-pressure turbine has a bearing at each end of the turbine rotor, and the low-pressure element has a bearing under each end of the low-pressure turbine rotor. The exhaust end of the high-pressure turbine cylinder is carried on the base of the low-pressure turbine cylinder. The complete unit as shown in Fig. 2 is supported by three transverse foundation beams; one under the turbine thrust pedestal; one between the high and low-pressure cylinders; and one between the low-pressure turbine and the generator. This method of independently supporting the critical sections of the turbine eliminates changes in alignment with changes in either load or throttle steam temperatures.

Governor

The unit has a fully hydraulic governor and control system, shown in Fig. 4. The operating and lubricating oil is supplied from an impeller, Fig. 7, which is integral with the main shaft. By the use of the hydraulic governor and speed-responsive element, the conventional gearing, flyballs and knife edges are eliminated. By the use of the main oil pump integral with the shaft, the necessary right angle gearing and shaft driving a pump in the main lubricating oil tank are eliminated.

The unit is provided with a shaft vibrometer, Fig. 9, which indicates and records the vibration of the turbine shaft. Two explosion doors are located on top of the low pressure turbine but the unit is normally automatically tripped by a low vacuum device set to operate at about 13 in. Hg. During shut-downs the high-

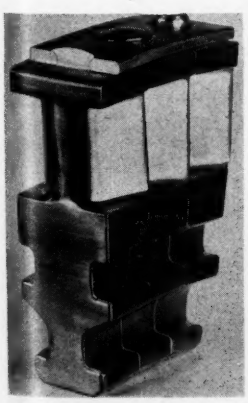
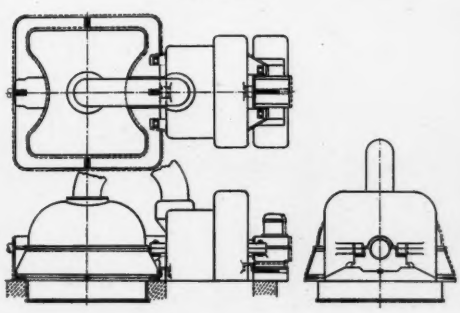


Fig.1—Left. Section of heavy-duty impulse wheel. Fig. 2—Below. Diagram of turbine unit, showing transverse foundation beams. Fig. 3—Right. Portion of last row blades in double-flow low-pressure element



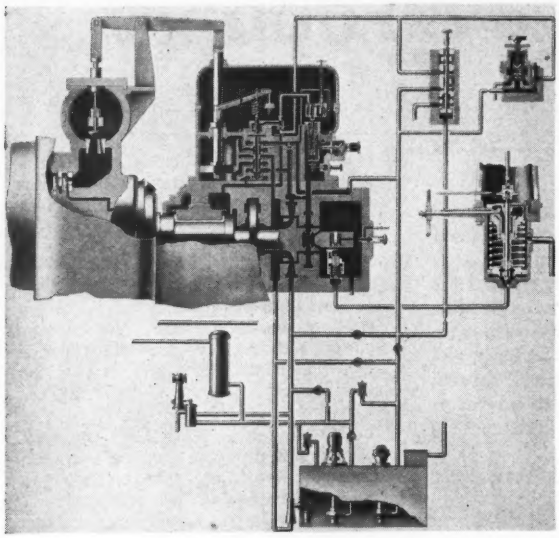
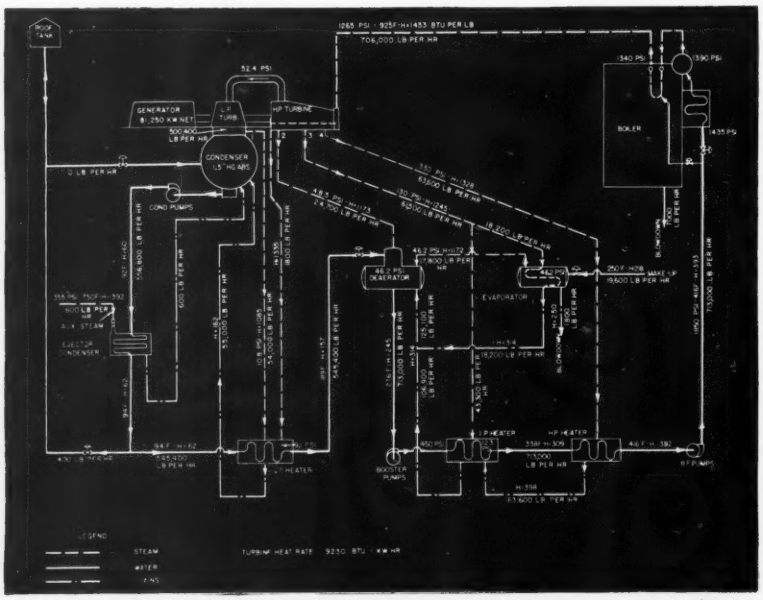


Fig. 4—Left. Phantom diagram of hydraulic governor and control system for Springdale 80,000-kw turbine. Oil supply from impeller integral with main shaft. See also Fig. 7

Fig. 5—Below. Heat balance diagram for complete new Springdale unit at 81,250 kw load



speed turning gear revolves the spindle at 30 rpm to insure maintaining an adequate oil film.

The turbine oil reservoir is located remote from the turbine in a separate room protected by a Grinnell Co. mulsifyre system. Heat-actuated devices automatically close the fire doors and automatically operate a deluge valve. This room also contains the oil coolers, transfer oil pumps and a Bowser oil filter.

Condenser

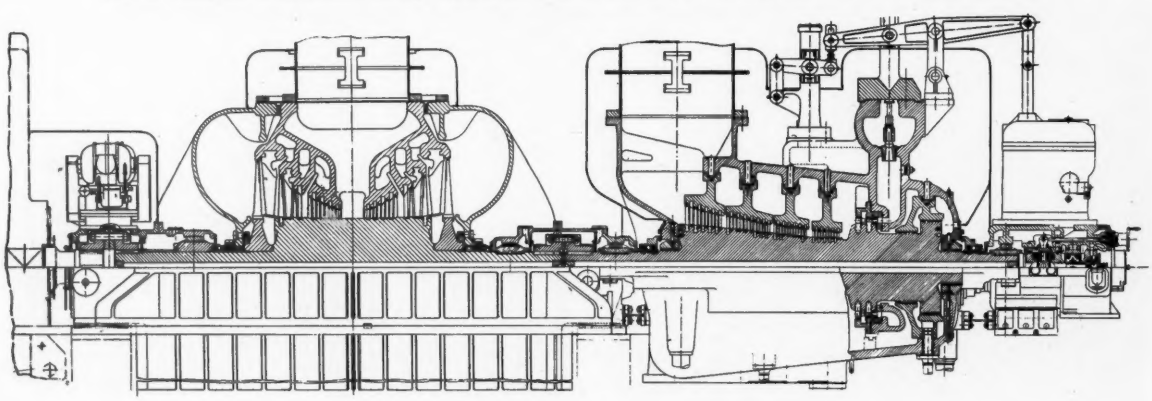
Steam exhausted from the turbine flows to the 50,000-sq ft Westinghouse condenser of the single-pass, radial-flow type, with divided cast-iron water boxes. There are 9150 tubes, ⅞ in. I. D., of No. 18 BWG arsenical admiralty metal. Tube plates are of Muntz metal. Tubes are expanded at both ends. Steel diaphragms at both ends of condenser take care of tube expansion. All tubes are bowed so as to be self-draining. The partition between the inlet water boxes is equipped with a Chapman motor-operated sluice gate. Circulating water velocity at full load is 7.25 ft per sec.

The hotwell is of the deaerating type and free oxygen in the condenser is not over 0.04 ppm. Condensate temperature leaving the condenser approximately equals vacuum temperature. The condenser is spring supported and is bolted directly to the turbine exhaust nozzle without the use of an expansion joint.

Hotwell level is maintained and records are continuously made by utilizing a Hagan pneumatic water level transmitter in conjunction with a Bailey pressure recorder controller. To keep a running check on condenser tube cleanliness, the pressure drop across the separate sections is recorded by action of a Hagan pneumatic differential pressure transmitter operating a Bailey pressure recorder.

The two condensate pumps are three-stage vertical centrifugal pumps furnished by Westinghouse Electric Corp. and have a capacity of 1400 gpm at 1170 rpm against a total dynamic head of 300 ft. The first-

Fig. 6. Complete cross-section through Springdale turbine unit No. 7, showing high and low-pressure elements



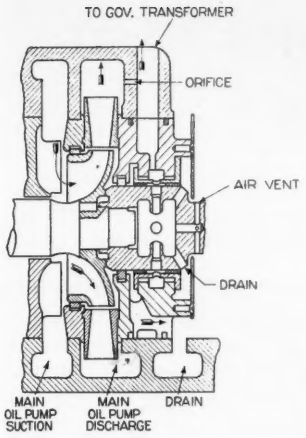


Fig. 7—Left. Detail of operating oil pump, showing impeller on main shaft supplying operating and lubricating oil for hydraulic governor and control system

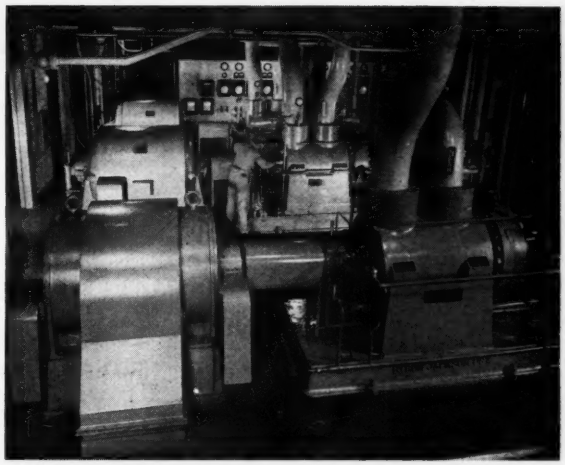


Fig. 8—Right. Three boiler feed pumps of 500,000 lb per hr capacity each, 1840 psig discharge pressure, 440 psig suction pressure; each driven by 1400-hp, 3600-rpm motor

stage runner is double suction and the second and third-stage runners are arranged back-to-back and are of the same diameter. Consequently there is no resultant hydraulic thrust on this pump. The upper gland is subjected to the pressure developed by the first two stages of the pump and this pressure is always above atmospheric under any operating conditions including extreme light load. There is no gland at the lower end of the shaft, the bearing terminating in a cover plate. The shaft is carried on two micarta bearings, one located below the first stage runner and the other above the third stage runner. The bearings are internally lubricated by the condensate being pumped. The feedwater is free of impurities and makes an excellent coolant and lubricant for the bearings.

Circulating pumps are 48 in. diameter discharge, vertical, single-inlet, bottom-suction, propeller-type pumps, furnished by Westinghouse Electric Corporation.

The feedwater drain control on the high, intermediate and low-pressure heater consists of a Hagan pneumatic level transmitter controlling spring-loaded diaphragm actuated flow control valves. The heater water-level control is a combination Hagan-Bailey arrangement in which the feedwater

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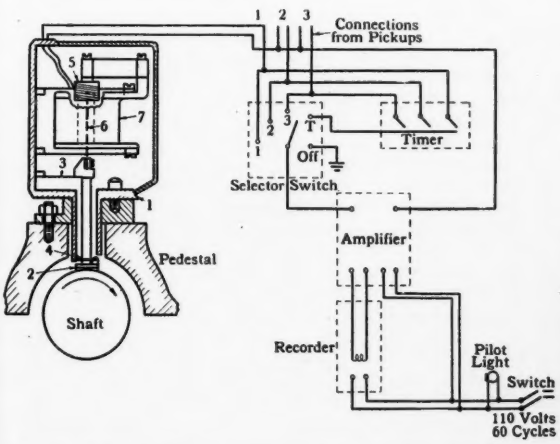

Fig. 9—Left. Diagram of vibration meter with attendant instruments, including selector switch for monitoring various positions

Fig. 10—Below. Turbine, pump and heater control panel for Springdale 80,000-kw unit, on turbine operating floor, centralizes all supervisory instruments and controls

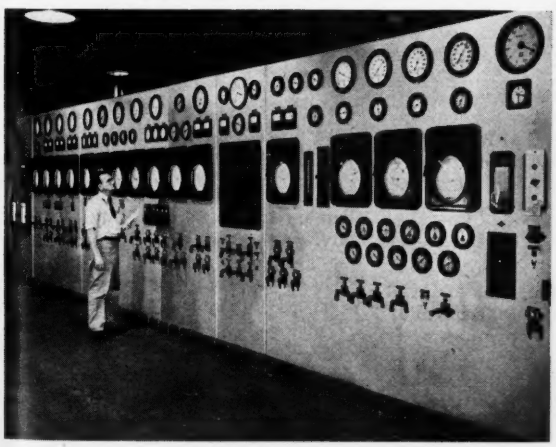

Fig. 11—Below. View of 50,000-sq ft main condenser for Springdale Unit No. 7, showing inlet water boxes

What Characteristic Means in a Diaphragm Control Valve

By **BRUCE IRWIN** Hammel-Dahl Co., Providence, R. I.

It means simply how the valve acts to control flow . . . Valve is an "engineered obstruction" in a pipe . . . This article shows how it should be and can be engineered to do exactly what the control instrument commands . . . Three types: quick-opening; linear or parabolic; equal-percentage . . . How they are built, how they operate . . . What valve coefficient is, how obtained, how used in calculating valve action . . . How to figure control valve capacity and size . . . How to analyze and calculate an entire system: pressure drops in valve and piping, flow in system . . . Besides showing mathematical methods of valve selection and sizing, this article emphasizes that there is no substitute for good engineering judgment . . . Examples of how to apply it to control valves

MANY control specifications go into multitudinous instrument details as to range, chart drive, instrument sensitivity, accuracy of pilot output, pilot capacity, deviation from the mean, hysteresis, and so on, but they generally end up by saying, "One 4-in. control valve, extra-heavy cast-iron flanged body, stainless steel trim." Regardless of how well the instrument can measure the condition to be controlled, unless the control valve does exactly what the instrument commands, you have an unsatisfactory control installation. Let us, therefore, examine this thing called a diaphragm control valve to see (1) what it is, (2) how it functions mechanically, (3) what we mean by valve characteristic.

Basically, a diaphragm control valve is a means of introducing a variable resistance into a fluid flow system. Under low flow conditions, the control valve must dissipate energy in the form of pressure drop across the valve plug to permit the desired flow rate. When high flow rates are demanded, little energy is dissipated. The variation in energy absorbed by the control valve is governed by its ability to vary port area. A definition of a control valve might then be "The means of introducing variable resistance into a fluid flow system" or, as Ed Dahl facetiously classifies it, "An engineered obstruction in a pipe line."

Mechanically, most control valves consist of a valve body with a valve plug and stem attached to a diaphragm. The diaphragm is enclosed in a diaphragm case generally mounted on a spring barrel. Air loading on the diaphragm is balanced by some external force, generally springs. Variation in air loading pressure from the control instrument will cause the diaphragm to move. As this is connected to the valve plug, the valve plug will assume variable positions in relation to the seat of the valve body. For this reason, I might define a control valve as a "Diaphragm-operated Variable Orifice."

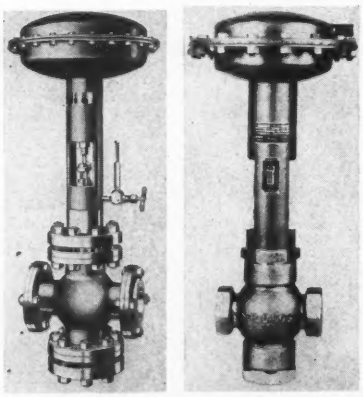

Fig. 1. Left—A flanged-end control valve with through-bolted bonnet and blind flange. Right—A screwed-end control valve

Any mention of the term "control valve" may be considered to refer to any of these diaphragm-operated valves: (a) Single-seated, such as spline, piston, needle, wedge, or step cone; (b) Double-seated, or balanced, such as parabolic, V-port or annular type; (c) Free-flow Venturi throat; (d) Pressure-balanced; (e) Three-way; (f) Butterfly 30°, 60°, 90° and V-port; and (g) Saunders' Patent.

There are two basic types of control valve action: "air-to-open" and "air-to-close." In former years, the terms "direct-acting" and "reverse-acting" were used but, owing to diametrically opposite use by various manufacturers, these terms have been largely dropped. In most cases, the pressure variation applied to the diaphragm to stroke the valve completely is normally 0-15 psi, although practically, it will run about 2-14 psi to insure: (1) definite spring closing in the air-to-open type; and (2) that the 15-lb output of the controller will tightly close or completely open the valve.

Actually, the spring range of the diaphragm control valve must match the instrument pilot range.

While the more usual range of valve loading is 0-15 psi, some manufacturers use an 0-25 psi range. Regardless of the pressure range, the diaphragm valve is supposed to position the valve plug in a definite reproducible position for a given loading pressure sent from the control instrument. It also should respond to the most minute change in output pressure from the control instrument.

Let us assume that we have a perfect diaphragm superstructure and a frictionless stuffing box on the valve body. Based on this assumption, the most important factor of control valves left to discuss is control valve characteristics.

In general, the three most common valve characteristics are (a) Quick-opening; (b) Linear; and (c) Equal percentage or logarithmic. Figure 2 illustrates each of these constructions in solid plugs, which operate on an annular basis, although the same characteristics could be equally well produced by a V-port plug or several other types of construction.

What Are Valve Characteristics?

The question of control valve characteristic, briefly stated, is, simply, "How does the valve act?" In the beginning, control valves were made with quick-opening or bevel-seated valve plugs, single or, preferably, double-seated. The lift in these valves was generally ¼ D; D being the seat diameter. Valve lift was arrived at by dividing the seat areas $\pi D^2/4$ by the seat perimeter πD giving the maximum useful lift of D/4. The flow curve generated is a

From a paper before the first regional conference of the Instrument Society of America, Detroit, Mich., April, 1946.

straight line at constant pressure drop through most of the travel.

As long as thirty years ago, it appeared easier to control flow by increasing valve lift. Consequently, a double-seated skirted type plug with four equilateral triangular ports in each skirt was manufactured. While the word "V-port" describes the construction accurately, the valve port area as a lift relationship actually produces a parabolic curve. The lift is generally several times that of bevel-seated plugs.

Approximately fifteen years ago, the solid-type parabolic plug was introduced. The plug contour and flow behavior produced at that time can be accurately described as parabolic. The lift of this valve was several times that of a bevel-seated plug, but generally less than a V-port.

Present-day thinking is about evenly divided between the parabolic (linear) flow curve and the equal percentage (logarithmic) flow curve. Both types have distinctive characteristics and advantages. Let us first define each type of characteristic and then state the proper application of this characteristic in general terms.

"A control valve with a parabolic (linear) flow characteristic will produce constant unit change in flow for a unit change in lift at constant pressure drop."

This type characteristic should be used when the pressure drop in the system is largely concentrated across the control valve and the majority of the energy in the system must be dissipated by the control valve. The parabolic (linear) characteristic should also be used when the ultimate maximum capacity of the valve body is required.

"A control valve with an equal percentage (logarithmic) flow characteristic will produce constant rate of change in flow for a unit change in lift at constant pressure drop."

The change in flow is always proportional to the flow rate, just before the change was made, regardless of whether it is an increase or decrease.

The equal percentage (logarithmic) characteristic should be used when the majority of pressure drop or energy is **normally** absorbed by the system with only a small proportion of pressure drop concentrated across the control valve, yet under low rates of flow practically all the pressure drop may be concentrated at the valve. Even with variable flow and pressure drop this characteristic will provide uniformly satisfactory control at any point of lift in excess of clearance leakage. This type characteristic should be selected when operating conditions cannot be determined and it is necessary to install a valve line size.

Figure 3 is a characteristic plot on uniform coördinates of a quick-opening plug, a parabolic or linear plug, and an equal-percentage valve plug. The quick-opening plug generates a straight line for about 70 per cent flow and the valve travel is only 30 per cent of the other types. This type of plug is satisfactory with constant pressure drops or on open-and-shut service. The parabolic or linear valve plug gives about 50 per cent capacity at 50 per cent opening. The equal-percentage plug gives about 13 to 15 per cent capacity at 50 per cent lift or opening. I should point out again that the actual lift in inches of the parabolic and equal-percentage curves is several times that of the linear plug.

Figure 4 shows exactly the same information as Fig. 3, except that semi-logarithmic paper is used. Valve travel-per cent opening has the same uniform coordinates but per cent of maximum flow is plotted on a logarithmic scale of two cycles: the first from 1 to 10; the second from 10 to 100. Inasmuch as the equal percentage characteristic is **logarithmic** it plots as a straight line

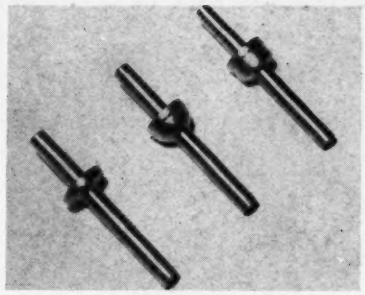

Fig. 2. Three control valve plugs, showing the three common characteristic types: quick-opening; parabolic or linear; and equal-percentage or logarithmic

on this type graph paper, just as the parabolic or **linear** characteristic plots as a straight line on linear paper.

The information on both linear and semi-logarithmic plots is informative but still only qualitative. In order to present quantitative information on valve lift and flow, the definition of a control valve as a "Diaphragm Operated Variable Orifice" suggests the idea of a valve coefficient (C_v), which in terms of flow characteristics, and valve sizing calculations, is analogous to the discharge coefficient, C, in orifice metering calculations.

What the Valve Coefficient Is

An example familiar to all is the practical orifice meter formula for liquids, $Q = C\sqrt{h}$

Q = Liquid in gph at 60 F.

C = The coefficient or quantity of liquid flowing through the orifice when there is 1 in. of water differential.

h = Differential in inches of water.

This formula is exactly the tool we want for valve work, but the units are not suitable. Valve flow coefficient (C_v) is therefore defined as the flow of water through the valve at any valve lift in gpm at 1.0 psi pressure drop. Although C_v can be calculated for all intermediate posi-

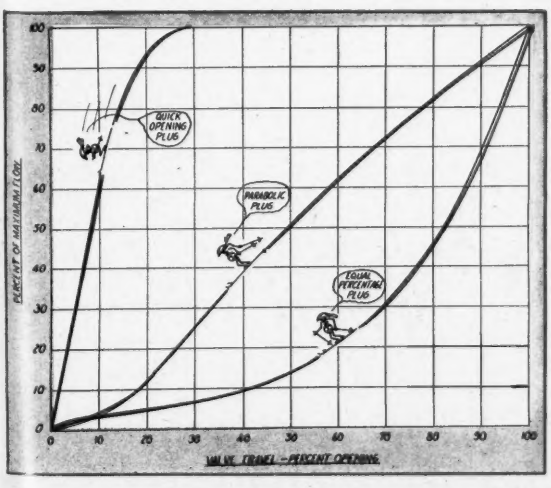

Fig. 3. Plot on uniform co-ordinates of characteristics of quick-opening, linear and equal-percentage control valve plugs

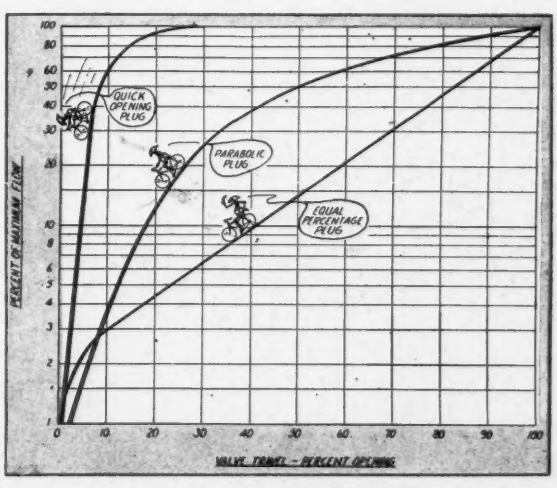

Fig. 4. Plot on semi-logarithmic co-ordinates of same data for three types plotted on Fig. 3.

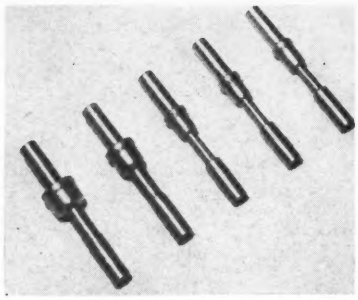

Fig. 5. Showing constructional features of family of five equal-percentage cone plugs having consistent flow behavior

tions of plug lift, all C_v listed in this article refer to the capacity of the valve at maximum plug lift.

The C_v of a given valve is the same for all fluids handled by the valve whether liquid, steam or gas. If all flow conditions are known C_v can be calculated from formulae to be stated later regardless of the flowing fluid.

The valve coefficient with the plug at maximum lift (valve fully open) accurately expresses the actual port area of the valve and is a number which can be used to state the valve's relative capacity. For example, the C_v max of a 1-in. valve is 10. The value of 10 (C_v) is always understood to mean gpm flow of water at 1 psi pressure drop.

As control valves are built in rational sizes above 1 in., Cv_{max} for a 2 in. valve would be $2^2 \times 10 = 40$; for a 4 in. valve, $4^2 \times 10 = 160$; for a 10 in. valve, $10^2 \times 10 = 1000$.

Plotting the Characteristics

Figure 5 illustrates the constructional features of a family of five equal-percentage cone plugs, which have consistent flow behavior. Their principal features are: (a) A series of angular cuts on a piston plug which can be reproduced in any instrument shop in an emergency; (b) common seat-ring, O.D.; (c) three seat sizes only, which frequently requires only a plug and stem change to change capacity; (d) high lift (½ in. in all sizes); (e) related maximum flow capacities; (f) reversibility from air-to-open to air-to-close action by reversing valve body; (g) tight shut-off; and (h) top and bottom guiding.

Figure 6 plots valve lift in inches versus C_v—flow coefficient of the family of quintuplets shown in Fig. 5. We now have quantitative information and a definitely more useful type of curve than either Fig. 3 or Fig. 4. In addition to the information given by Fig. 4, we find the following: (a) The relative capacity of the various valves; (b) the ability to calculate accurately valve lift in inches at intermediate and low flows; and (c) a means of numerically expressing actual valve capacity.

Let us assume we have selected a ½ in. valve with a C_v of 4 as being suitable for maximum flow conditions, but wish to see what it will do at minimum flow conditions, namely 1 gpm of water at 25-lb pressure drop. The C_v calculates $1 \div \sqrt{25}$ or 1/5 or 0.2. You will note a ½ in. valve will have a lift of 0.12 in. at this flow rate.

Figure 7 plots the percentage of maximum lift versus C_v for double-seated percentage plugs in sizes 1 in. through 12 in. These curves will permit the same type of analysis as mentioned for the equal-percentage cone plugs. In sizes 6 in. and over, a skirt-type valve plug which produces the same flow characteristics can be used. When the valve lift is known, it is possible to calculate the valve capacity at any point of valve travel.

Basic Flow Formulas

Basic flow formulas to determine valve capacity, with C_v and the flowing conditions given, are:

Liquid:

$$Gpm = C_v \sqrt{(p/G)}$$

Steam:

$$W = 63C_v \sqrt{(p/V)}$$

Gas:

$$Q = 1360C_v \sqrt{[(pP)/(460 + °F)\,G]}$$

$$W = 104C_v \sqrt{[(pPG)/(460 + °F)]}$$

C_v = Flow coefficient of valve
d = Valve size in inches
°F = Inlet gas temperature
G = Specific gravity
Gpm = Gallons per minute
P = Inlet pressure in psi absolute
p = Pressure drop across valve in psi for steam or gas not greater than P/2
Q = Cubic feet per hour at 60°F and 14.7 psi absolute
V = Specific volume of inlet steam
W = Pounds per hour

Flow Coefficient

d	C_v	d	C_v
¼	1.0	2	40
½	1.6	2½	63
¾	2.5	3	100
1	4.0	4	160
1¼	6.3	6	360
1	10	8	640
1¼	16	10	1000
1½	25	12	1440

When p, the pressure drop across the valve for steam or gas, becomes less than one-half the inlet absolute pressure P, any reduction in outlet pressure below ½ of the absolute inlet pressure will give no further increase in flow. This is known as critical flow. All compressible fluids follow this law approximately.

How to Determine Valve Size

If all the flowing conditions are known, and it is desired to determine C_v and a definite valve size, the above formula may be written as follows:

$$C_v = Gpm \sqrt{[G/P]}$$

With gas and steam similarly expressed, when C_v has been determined, it is only necessary to select a valve with a C_v equal to or greater than the calculated value.

If a definite size valve with a maximum C_v has been been selected, and it is of interest to determine valve

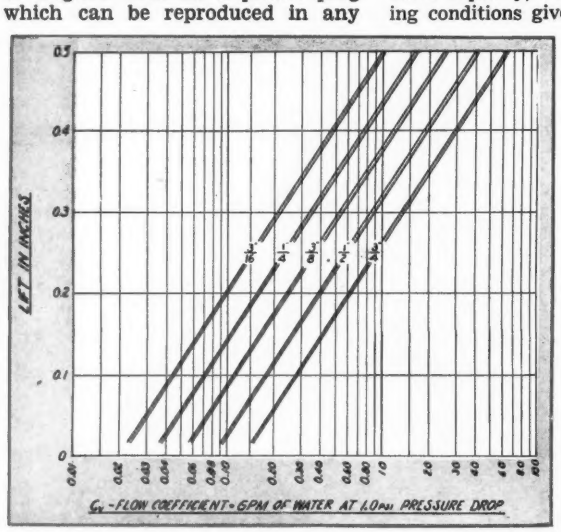

Fig. 6. Valve lift in inches plotted against flow coefficient for the family of plugs shown in Fig. 5

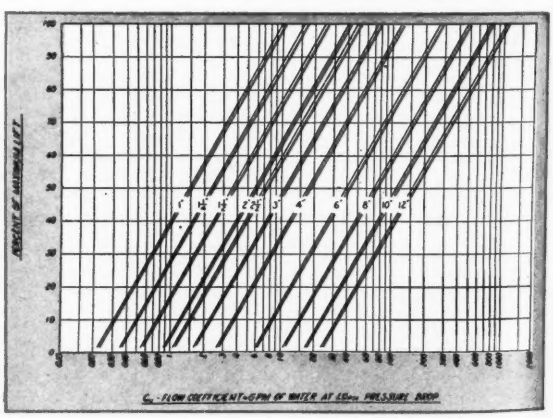

Fig. 7. Percentage of maximum lift plotted against flow coefficient for double-seated equal-percentage plugs, sizes 1 in. through 12 in.

lift at intermediate or minimum flow rates, it is only necessary to calculate the C_v for these conditions. The actual percentage lift or lift in inches can then be determined by reference to the proper flow curve, shown on Fig. 7. For example, a 1 in. valve has a C_v maximum of 10. Now, if the flow of water is 1 gpm and the pressure drop is 9 psi, can the valve handle this condition and, if so, what is the lift? C_v calculated 0.33. By referring to Fig. 7, you will see we have 11 per cent lift.

A much simpler, quite accurate, and much more rapid way of determining valve size is to use a capacity chart.

Figure 9 illustrates flow capacity from a 3/16 in. valve plug ($C_v = 1.0$) to a 12 in. valve with a capacity ($C_v = 1440$). The chart is easy to read. For example, let us assume the flow rate of 150 gpm of water at 25-lb pressure drop. We merely have to follow the 150 psi line horizontally until it intersects with the vertical 25-lb pressure drop line. You will note this point is above a 1½ in. size and below a 2 in. size. We would, therefore, select a 2 in. size valve. Specific gravity correction can be made by using the specific gravity curve shown at either the left or right-hand side of the chart.

By inspection of this chart it is possible to read the capacity of valve sizes up to pressure drops of 800 psi. Figure 9 also illustrates engineered design. You will note the valve coefficients: starting at 3/16 in., they are 1.0, 1.6, 2.5, 4.0, 6.3, as size increases to ¾ in. Starting with the 1 in. valve, we have a series similar but ten times larger; namely, 10, 16, 25, 40 and 63 through the 2½ in. size. These are ASA Preferred Numbers, each number being 60 per cent greater than the preceding number. Simply stated, a mathematical series of this sort gives uniform steps. This happens to be a 60 per cent series. Such series are used in the design of the capacity of motors, pumps, or refrigerators, so there is a sensible size relationship. You will notice that this series carries on through the 4 in. size valve.

My basic philosophy of control valve sizing is that a 1 in. valve should have a capacity of 10 gpm or a C_v of 10. Consequently, as pipe size is rational above 1 in., you can mentally calculate the C_v for any size valve, merely by squaring the valve size and multiplying by 10. You will note that this calculation is true, except for the 3 in. size, where we have taken the "preferred" number of 100, rather than 90. In sizes 6 in. and larger, valve body size controls and the preferred number series disappear.

Use Engineering Judgment

These formulas and charts give a logical mathematical approach to valve selection or sizing, but there is no substitute for good engineering judgment. There is a tendency to accept the field data given as being accurate and then perform a mechanical mathematical operation. There is also a tendency to concentrate our thinking on the control valve and disregard the characteristic curve of the pump, the piping, heat exchangers or other equipment which may definitely influence the ability of our valve to control flow in the system. Let us evaluate some of these factors.

Two types of pressure drop are usually encountered:

(1) Where the initial and terminal pressure are constant regardless of flow (e.g., make-up of low-pressure exhaust steam from the high-pressure system). This type of application concentrates pressure drop at the control valve; and line friction can be disregarded.

(2) Where the control valve is in series with heat exchangers, piping, and other resistances. These other factors may influence the controllability of the system as much as the control valve does—or even more. Unless the line size is infinite they will affect the characteristic curve of the system. Qualitatively expressed, the pressure drop available to the valve is low at high flows and high at low flows.

In class (1) above the preferred flow characteristic is parabolic or linear. In class (2) an equal percentage or logarithmic curve is the logical choice.

If pressure drop across the control valve must be selected arbitrarily, a good rule of thumb is to assign ⅓ of the total to the control valve and ⅔ to be absorbed by the balance of the system. A mathematical presentation of this suggested division will be discussed later.

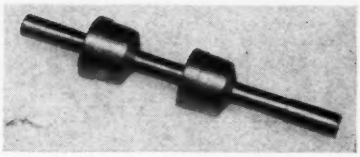

Fig. 8. This is the equal-percentage type of plug used to produce the curves of Fig. 7

In process applications where the ratio of maximum to minimum flow is not over 3, as little as 15 per cent of the total system drop will provide satisfactory control. This is definitely the low limit and a higher percentage of system drop should be used wherever possible.

If it is necessary to install a control valve arbitrarily with no knowledge of operating conditions, install the valve one size smaller than the line. If a control valve works out line size, the calculations by which the pipe size was determined should be checked, as the piping system including hand valves, fittings and heat exchange will probably absorb too much pressure drop to permit good control.

As will be demonstrated later, the maximum rate of flow should not exceed twice the normal rate of flow. The stated value of the coefficients (C_v) listed previously are conservative, therefore if actual data are available, 100 per cent of valve capacity can safely be used.

(*Continued on page 132*)

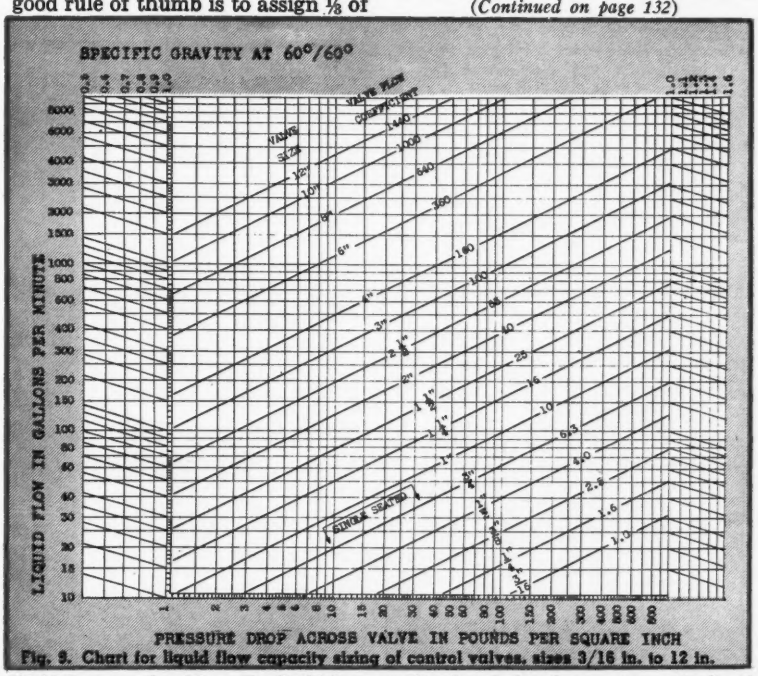
SPECIFIC GRAVITY AT 60°/60°
LIQUID FLOW IN GALLONS PER MINUTE
PRESSURE DROP ACROSS VALVE IN POUNDS PER SQUARE INCH
VALVE PLUG DESCRIPTION
VALVE SIZES
SINGLE SEATED

Fig. 9. Chart for liquid flow capacity sizing of control valves, sizes 3/16 in. to 12 in.

Liquid flow capacity sizing. The liquid flow capacity chart is based on water as the liquid material. To use the chart for any other liquid, the liquid flow rate must be such that the Reynolds number is greater than 4000, and liquid must not vaporize in the valve. Locate the intersection of the rate of flow in GrM and the Specific Gravity lines. Draw a line parallel to the sloping lines toward the middle of the chart to the Specific Gravity line of 1.0. Continue on the horizontal to the intersection with the pressure drop line. The valve size line passing above this point is the required valve size.

What You Can Do to Prevent Power Plant Casualties

By **ROBERT HENDERSON EMERICK** Consulting Mechanical Engineer

Fig. 1. The photograph above shows damaged condenser and exhaust nozzle. Explosion was caused by cutting torch which was being used to make piping changes; hydrogen accumulation in condenser following acid cleaning was ignited by torch. (For complete story, see pages 64 through 68, March, 1946, Power Plant Engineering)

FOLLOWING a long shut-down for cleaning, a 500-hp water-tube boiler in a large Eastern power plant began to prime almost at once when returned to the line. The priming grew worse; blowing down and water treatment seemed unable to check it. Two days passed in this way before someone connected the priming with the person of a missing boiler-plant laborer. They opened the boiler then, and found his overalls, and some bones, in the steam drum.

This sort of thing does not occur every day, but it does occur often enough to constitute a definite hazard in the operation of every power plant. It occurs as the result of supervising weakness. The National Safety Council, studying a lengthy accident report by the U. S. Army Engineers, points out that in three of every five accidents, the supervisor was not present at the time, and also, that in nearly one third of the accidents, failure of the supervisor to enforce safety requirements was a contributing cause.

THE AUTHOR

Robert Henderson Emerick was released from active duty in the U. S. Navy last April, after nearly four years of service. Before we received the present article from him recently, the last thing we had heard was that he was a Lieutenant-Commander. At that time, he sent us the very fine article. "Some Aspects of the Outdoor Power Plant," published in our May, 1943, issue.

After leaving the Navy, he and his family went south to St. Petersburg, Fla., where Mr. Emerick opened his own office as a consulting mechanical engineer. He is also putting the finishing touches on a textbook called "Introduction to Refrigeration and Air Conditioning." Before the war, he had served for a number of years with the Philadelphia Steam Co., then as mechanical engineer with Phoenix Engineering Co. (Electric Bond & Share Co.) and for a time had been in charge of boiler sales in New England for Henry Vogt Machine Co.

SUGGESTED FORM OF RECORD FOR CASUALTY DRILLS

1. Simulated Casualty: Fire in Tool Room.
2. Date: September 30, 1946.
3. Time of Alarm: 3:05 P. M.

Name	Casualty Station	Time in Minutes to Reach Station	Satisfactory
Jack Smith	In General Charge	3	Yes
Fred Doe	Operating Fire Extinguisher Unit No. 1	6	No
Dick Roe	At Telephone	2	Yes
Tom Jones	Roving	7	No

Reasons for Unsatisfactory Performance: .....

Time Required to Reach Stations Checked By. .....

Umpire .....

Authenticated By. .....Chief Engineer

Note: Casualty drills should be authorized, and their nature established beforehand, by the Chief Engineer. The Umpire may be any designated assistant. Plant personnel should not be forewarned of the drill, except in those cases that might affect plant operation through men leaving their regular duty stations, or shutting down plant equipment, with the thought that a real casualty actually had occurred.

Inspect, Interpret, Rehearse . . . These three, incorporated in the operating procedures of any power plant, forestall casualties, limit scope of those that do occur . . . Here are specific examples showing why these precautions work and what you can do to use them on men and machines . . . Adequate inspection by supervisors, adequate enforcement of safety rules are essential . . . Inspection and checking must be done with imagination and foresight . . . How to prepare for fires . . . Chiefs must educate men

In every power plant, closing up of boilers should take place under the direct supervision of the chief engineer, or equivalent authority. Delegating this responsibility down the line too often has been a direct cause for the loss of life, a loss of load, or both.

For instance, on a Navy warship, a chief water-tender being temporarily diverted from completing his inspection of a Scotch boiler, delegated the closing of the manholes to an assistant. Returning to the job, he found the boiler feed steadily filling the boiler, and one of his men missing. Everyone but the chief was surprised when they turned off the feed and found the missing man inside the boiler, fortunately unhurt.

In a public utility power plant, the solid cast-iron coupling connecting a steam turbine to a centrifugal boiler feed pump, failed under a heavy load. The turbine ran away and sizeable parts left the building without stopping to find the door; they went right through the brick wall.

Why did the overspeed trip on the turbine fail to work? Apparently for the same reason that it also failed to work on three or four other feed pump turbines in the same battery. No one had checked these trips for many months, therefore nobody knew they were so badly out of adjustment as to be inoperative.

Use Imagination and Foresight

Checking turbine trips should be a routine job in every plant, but checking is not always enough to avoid casualties. Imagination is necessary too.

For instance, the district heating plant in a large city found itself, one winter, with a load of slagging coal. On the coldest day of that particular winter, they decided to burn it up. The coal promptly slagged the waterwall tubes of the boilers, and spread like congealing lava over the tuyeres of the underfeed stokers. At the moment, the load on the plant was hitting a new peak.

The steam pressure melted away. All auxiliaries were steam driven and, as the pressure fell, they slowed down, aggravating the overall picture. In a desperate attempt to clear the slag with lances, many of the plant personnel were knocked out by gas. Finally, half the load was dumped to maintain reduced service on the other half.

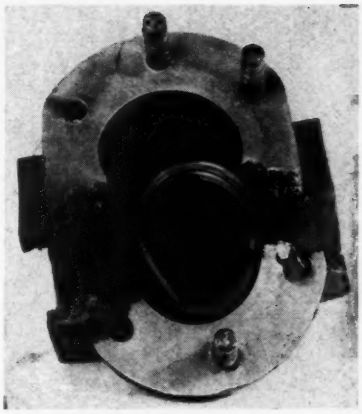

Fig. 2. This compressed air line valve burst while under 225 psi pressure, apparently from a body flaw. The missing parts penetrated a ¼ in. steel plate fifty feet distant. High pressure valves and fittings should be inspected regularly for the first few months after going into service to discover any developing cracks or dangerous porosity

A little imagination exercised in connection with that slagging coal, before it was burned, would have avoided the casualty. Sometimes imagination and foresight are identical.

Are You Prepared for Fires?

How many power plants are prepared for a fire? Do all the new men know how to use the hand extinguishers? Are the fire pumps, valves, and hoses tested periodically? And here is one of the most important questions of all: Does every individual on every shift know exactly what he, personally, is to do in the event of a fire?

In some plants, such as an oil refinery or a gas plant, the consequences of a fire can be so terrible that even the word is never spoken aloud, deliberately. And yet—this writer was present at a gasworks fire in which the volume and pressure of the water delivered from the fire pumps approximated the drip from a leaky bathroom faucet.

Fire panic can aid and abet the growth of a fire by: first, abandoning the fight at a crucial time; and second, by confusing the efforts of those who do attempt to bring a fire under control. In a public utility fire that started from a short-circuited ground cable, a young engineer ran amok and seriously interfered with the efforts of other personnel who were attempting to stop generators and to kill live circuits. Later, another man was forced to give up his fire-fighting to prevent the lad from

SUGGESTED FORM OF CASUALTY BILL FOR BOILER ROOMS

Name	Regular Duty	Assigned Duty at Times of Fire, Explosion, and Dangerous Gases Escaping
Jack Smith	Boiler Room Engineer	In general charge, supervising control of damage, removal of injured. Responsible for Safety of outside personnel entering plant.
Fred Doe	Fireman	Obtain and operate Fire Unit No. 1, after making sure that all boilers are operating safely. In case of steam explosion, localize steam blasts. Assist as directed by Boiler Room Engineer.
Dick Roe	Fireman	Notify Chief Engineer, outside Fire Agencies, call for Medical and Police assistance if needed. As soon as possible, stand guard at doors and keep out unauthorized persons.
Tom Jones	Fireman	Assist others as needed. Act as Roving Assistant except as directed by Engineer.
Others		Assigned duties according to the situation.

Note: Similar Bills should be arranged for: A—The Turbine Hall or Engine Room. B—The Electrical Section of the Plant. C—The Outdoor and Miscellaneous Sections

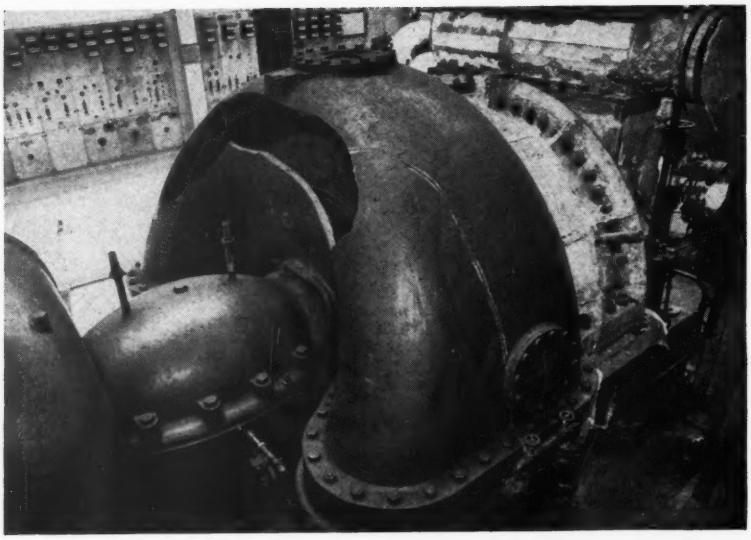

Fig. 3. This turbine exhaust case was damaged in the same explosion which wrecked the condenser shown in Fig. 1. (See March, 1946, Power Plant Engineering)

killing himself by jumping from an upper window of the plant.

Fire panic can occur at any time, but is less likely if every man knows what to expect at the onset of a fire, and then exactly what to do. Here again, faulty supervision can be blamed as a contributing cause.

Chiefs Must Educate Inexperienced Men

POWER PLANT ENGINEERING has carried many discussions concerning the chief engineer who regarded his specialized knowledge as something to have and to hold, within himself, exclusively, forever. Such men might be accused at times, and with some reason, of involuntary manslaughter. For instance, a night fireman in a boiler plant, when ordered to put a fresh boiler on the line, found the boiler valve to be sticking. A new man, this fireman, and working in a high pressure plant for the first time, he attempted to free the valve disc by slugging the body of the valve with a small sledge hammer. After the second or third blow, the life of the valve came to a sudden violent end, and so did the life of the man. Moreover the entire plant was shut down for many hours until a new valve could be found and installed.

Every chief engineer should consider himself responsible for the continued education of his men, and should be doubly careful of new men, for their well-meaning inexperience can lead to disaster.

Just Plain Weariness Causes Many Accidents

Power plant casualties, too often to be overlooked, result from simple weariness of the operators. Sometimes this is the fault of supervision, sometimes of the individual involved. Out on a Pacific Island, during the war operations, a night fireman fell asleep. Perhaps he was exhausted from long hours on duty, and his weariness was aggravated by the occurrence of alerts during the time he should have been resting. Firemen have slept on duty many times, and nothing happened. But on this one time the boiler feed pump chose to fail at the exact time he was dozing in his chair. The boiler, a large, sectional header cross drum unit, oil-fired, burned up. Although no physical harm was suffered by the fireman, the entire plant was crippled, and perhaps he wished he had been less lucky.

In a big city generating station, during some night repair operations, a man was being sent at frequent intervals to climb several flights of steps to an upper floor, where he alternately opened and closed a circuit breaker. Toward morning, he stopped one flight of steps too soon, and closed a disconnect switch in a 2200-v circuit. At the same instant realizing his mistake, he re-opened the switch. The plant then went off the line, and the man went to the undertaker.

Weariness was the fundamental cause for this casualty, but it might have been avoided if that man had been so trained that his instinctive reaction to a disconnect switch was "Stop, look, and consider." There is rarely time to meditate in emergencies, and what a man does, when mixed up in one, is almost entirely an instinctive movement, rooted in his previous training—or lack of it.

How a Minor Trouble Can Cause a Major One

Most power plant casualties are neither spectacular nor violent. A steam turbine, for instance, after carrying a heavy load for years without adequate attention, and suffering from a progressive erosion of the nozzles and steam cut leaks between stages, suddenly refuses one day, to accept its appointed burden.

In another plant, somebody is always over-lubricating a condensing steam engine, while at the same time nobody gives half enough attention to the filters. When the boiler foams

SUGGESTED FORM OF INSEPECTION RECORD IN BOILER ROOM

Name	Assigned to Inspect	Frequency	Condition Found	Date	Condition Found	Date
Fred Doe	Coal Bunkers for Incipient Fires	Weekly	O.K.	9/2/46	Temp. Up 15° Since Last Inspection	9/9/46
Dick Roe	Rotating Machinery	Once Each Shift	O.K.	9/2/46	O.K.	9/3/46
Tom Jones	Reciprocating Machinery	Once Each Shift	O.K.	9/2/46	Rod Scoring on No. 2 B.F. Pump	9/3/46
Jack Smith	Over-all Aspects of Plant	Complete Tour Once Each Week	O.K.	9/2/46	Excessive Dirt and Waste on Fan Floor	9/9/46

Note 1: Similar records should be established for the:

A—Turbine Hall or Engine Room

B—The Electrical Section of the Plant

C—The Outdoor and Miscellaneous Sections

Note 2: This Inspection Record should be prepared with the idea of recognizing potential casualties. The conventional inspections made by every group of shift personnel in every plant need not be included. If the shift is made sufficiently large, it will last for many months, and may be posted on a board in the section of the plant concerned. In this position, an overlooked inspection is quickly evident.

or primes, somebody adds more compound; only that and nothing more. And everybody is surprised, of course, when a boiler tube lets go and they find a lot of oil scale on the internal surface of the tube.

Bearings wipe out because, despite the presence of a lubricating oil centrifuge, shift engineers forget, or just neglect, to centrifuge the oil.

Planning for power plant casualties takes three basic forms, two of them preventative, one limiting.

Coming Trouble Often Casts a Shadow Before

First is inspection. At least once every week, a plant should be inspected for potential casualties. Often, the shadow of coming trouble is obvious, if we merely look in the right direction. In one large boiler plant, nobody looked up at the roof for years, or perhaps, because of the darkness among the lofty rafters, the contact of the wooden roof with the uncovered steel stack merely went unnoticed. Then, one winter night, during a time of heavy overload on the boilers, the old roof torched off. When finally the fire was put out, it already had spread so far, and had done so much damage, that the plant also was out, for a week.

A real inspection of potential danger areas, flavored with a dash of imagination, would have avoided this casualty.

Second is interpretation, the interpretation of operating phenomena. Machinery breakdowns almost always give warning of their imminence, if we simply understand their signals. Out in the Pacific war zone, one of the two main engines of a Diesel-driven tanker built up a history, over months of operation, of crankcase "puffs," minor vapor explosions that did no more damage than blow off the inspection doors. The warning was there, but nobody paid any real attention to it. One day, while traveling at full speed through dangerous waters, that engine put on a first class, major, crankcase explosion. Much of the engine was wrecked, and the ship was lucky to limp back to port on one engine. And she was out of the war for many months.

If a turbine develops vibration, or a reduction gear sets up an increasingly loud whine, the warning of an approaching casualty is there. We have the chance now to make the next move, and if we don't make it, the machinery will, perhaps to our everlasting sorrow.

Third is rehearsing. In this situation, the casualty has occurred, and we are concerned with limiting the extent of the damage. In the Navy, where damage control more often than otherwise is a matter of life and death, damage control drills are sometimes incorporated in the daily routine. Shore plants should simulate a casualty at least once a week, until every man in the plant reacts instinctively to his assigned emergency duties. After that, a drill every three weeks in large plants, and once a month in small ones, should be enough to maintain the correct reaction.

These drills will uncover some surprising conditions. Escape doors will be found locked, gas masks will be absent from their proper stations, fire hoses will be split, plant operators will not know just where to put their hands on key valves, or what switches to open and what switches to close. When these conditions exist, the chances for a casualty increase, for bad luck seems to have a supernatural flair for visiting plants that are unprepared.

Inspect, interpret, rehearse. These three words, incorporated in the operating rules of any power plant, can provide protection against casualties, and limit the scope of those that do occur.

Corrosion of Plant Equipment

(*Continued from page 75*)

it is desirable first to check to determine whether it is embrittling, that is, whether embrittlement may be expected to take place in the boiler. Testers are now available which can be hooked directly onto the boiler and in a month or so a determination can be made which will indicate whether there is likely to be embrittlement. Also samples of the boiler water can be sent to research laboratories for checking and the embrittling nature of the water determined.

If the water is found to be embrittling then anyone of several methods can be used for the prevention of embrittlement. Briefly these involve the use of quebracho tannin, lignins, sodium nitrate, etc. Since it is the hydrate alkalinity that actually causes embrittlement to take place, caustic embrittlement also can be prevented by maintaining the boiler water under such a condition that no free hydrate exists. Such a method known as the coordinated phosphate control has been developed in recent years.

TREATMENT OF OLD PITS—It often happens that where corrosion has occured to some extent in the boiler, that corrosion may continue even after the original cause of corrosion has been eliminated. This is usually due to the fact that the pits are filled with sludge or corrosion product which acts as a screen or plug under which concentration of boiler water can take place or under which the oxygen can become depleted. If the former occurs the protective film on the metal will be dissolved allowing corrosion to continue and if the latter occurs concentration cells may be set up and serious corrosion may result. Once corrosion has taken place and pits have formed, in order to be sure that this pitting will not continue, the pits should be cleaned out and maintained in this condition. In many cases old pits are painted with a protective coating. This may or may not be necessary but it should stop the corrosion.

General Conclusions and Suggestions for Future Study

In recent years there have been great strides in understanding the basic principles involved in corrosion of boilers and also in the means for preventing this corrosion from taking place. It would appear that most of these theories are the same as those which applied years ago. What actually has happened is that, because of increased pressures and temperatures, causes of corrosion that were not at all important at the lower pressures have now suddenly become quite important. This undoubtedly will be found to be true in the future, that is, as pressures and temperatures gradually become higher and higher, certain other factors will become more and more important. As mentioned, it would appear that the effect of pH, dissolved oxygen and the more or less common causes of corrosion are fairly well understood. Those involving copper, poor circulation, high heat transfer rate and other boiler design problems are not so well understood. It is along these lines that the greatest effort must be expended in the future if corrosion free boiler operation is to be insured.

(To be continued.)

Transformer Outages

(*Continued from page 80*)

carrying the heavier load would open first.[3] Such an arrangement would indicate positively the location of excessive loads. The operation of such transformers in a bank would be simplified greatly, and the possibility of a transformer being disconnected from the secondary mains in case of severe overload would be considerably lessened.

Figure 4 shows the actual installation of one of the 10 kva, 2-breaker, CSP transformers. Note the five secondary leads and the simple method of separating the "main" and the "section" secondaries by means of strain insulators.

The 2-breaker CSP transformer is a distinct contribution to the art of secondary banking and its acceptance by the utilities will depend on its cost relative to the conventional transformer or to the 1-breaker CSP transformer, the ease with which a bank can be designed and operated, and the savings that can be effected in reduced transformer capacity.

[3] This has been done in more recent designs of these transformers.

How a Diesel Will Fit in a Steam Plant

By A. C. KIRKWOOD Burns and McDonnell Engineering Co.

PEAKS and valleys of daily load curves have long wooed the imagination of most operators and many engineers. Legion are ideas and efforts used to level this summation record of the vagaries of man's demand for electric power. Specifics have been found for certain utilities, but only ceaseless effort has achieved any evidence of universal success. Today's load curves still show unwanted variations.

Fundamental habits of consumers prevent conversion of the normal, fluctuating loads to the idealistic constant load. Many engineers and operators believe that the load variations imposed upon steam-operated generating stations can be met desirably with Diesel engine generators.

An impartial approach is essential to successful consideration of the merits of a possible combination steam and Diesel plant.

Continued traditional support of either type of prime mover will not secure the mature judgment and full consideration required to determine the merits of a particular application.

Scope of Discussion

In general, steam plants are larger than Diesel plants. The same is true of the capacities of individual generating units of the two types. It is doubtful if any but the smaller steam plants would be supplanted by Diesel (or gas engine) plants. These small steam plants do not fall within the scope and intent of this discussion. It is obvious that the internal combustion engine-generator unit must be considered as an aid in the operation of a steam plant rather than as a main unit in that plant. The importance of the Diesel's role will depend upon the need for the unit and, if need there be, the cleverness with which it is used. Studies of daily load characteristics and changes therein are pertinent to best operation of the installation.

This paper was presented at the 18th National Oil and Gas Power Conference.

Assumed Generating Capacity

Included in operating files available to the author are detailed data for a system whose 1945 maximum hour (generation) was 19,100 kwh, whose gross output was 90,467,739 from 2/1/45 to 1/31/46, and for which load data had been compiled on an hourly basis. For purposes of this discussion, it is considered permissible to assume that the plant might at present consist of 2—5000 kw and 2—10,000 kw turbo-generators. Treatment herein is for an isolated plant. The annual demand is approaching rated firm capacity, consequently operating studies involving a possible Diesel unit must also be considered in the light of probable future loads.

An examination of hourly loads, day by day, shows several definite patterns. These patterns are so clearly defined that adequate accuracy can be assured if only every fourth week is examined in detail. A total of 13 weeks plus one extra day was used as the basis of this study. The calculated total annual generation was 90,392,200 kwh, the actual was 90,467,739 kwh.

Rolling Reserve

Operating schedules or procedures are not universally standardized, therefore the matter of rolling reserve capacity is debatable. A system employing a large rolling reserve will obviously have less use for a Diesel unit than a system operating with a minimum of rolling reserve. Studies used for this paper were predicated on a minimum rolling reserve. Thus, if a unit could be removed from service for some eight hours or more, it was removed and the operating economy of the remaining machines thereby improved. On the other hand, noon hour or late afternoon valleys were not considered adequate reasons for shutting down a machine. Examination of daily charts indicates that for each day of the week, definite prime mover schedules can be established. Seasonal influences can be coped with and week-end inspection periods can be planned in advance.

3000 Kw Diesel Unit

A 3000 kw Diesel generator was considered an appropriate sized unit. Using the procedure outlined briefly in the preceding paragraph, it was found that this unit could be operated economically 3630 hours during the year to produce 4,918,000 kwh. The average load would be 1360 kw. But, and this point is noteworthy, the bulk of the operating hours are not at the time of the daily peaks. It is obviously wrong to consider the Diesel unit as a "peak load" unit when applied to this type of service. It is, however, proper to consider the Diesel as a unit to improve operating load factors of other units, as a unit that can almost instantly accommodate sudden increases in plant load, and as a unit that can assist during peak loads. Table I shows the summary of annual operations with the 3000 kw Diesel unit installed and Table II without it.

The Diesel unit has, in this instance, successfully improved the operating

TABLE I

SUMMARY OF OPERATIONS—WITH DIESEL

Unit	Hours Service	Kwh Generated	Average Load, kw
5,000 kw, TG	695	3,434,200	4,930
5,000 kw, TG	5,065	24,853,000	4,920
10,000 kw, TG	0	0	0
10,000 kw, TG	6,792	57,187,000	8,450
3,000 kw, DEG	3,630	4,918,000	1,360
		90,392,200	

TABLE II

SUMMARY OF OPERATIONS—WITHOUT DIESEL

Unit	Hours Service	Kwh Generated	Average Load, kw
5,000 kw, TG	1,356	4,296,400	3,180
5,000 kw, TG	2,308	9,494,000	4,100
10,000 kw, TG	3,871	23,270,800	6,010
10,000 kw, TG	7,344	53,331,000	7,290
		90,392,200	

How a Diesel generator can be effectively used in a specific 4-unit 30,000 kw steam plant . . . Study based on minimum rolling reserve . . . 3000 kw Diesel generator selected as appropriately sized unit for this plant . . . Comparison of annual fuel costs using steam only and using steam and Diesel in combination . . . Studies and tables included for load growth up to 100 per cent increase in demand . . . Diesel generator not to be considered as standby or peak load unit . . . Must be allowed to play its assigned role as part of the base load equipment . . . Diesel's effect on plant firm capacity affords value in addition to fuel saving

load factor of each turbo-generator. As will be seen, this has been done at a saving in total fuel cost. Table III shows comparative fuel costs resulting from use of the two operating procedures.

Fuel Costs

Diesel fuel oil has been priced at $0.04 per gallon, roughly $0.26 per million Btu. Using guarantees for similar engine generator units, fuel costs have been assumed at $4.40, $6.20, and $8.24 per hour for ½, ¾, and 4/4 load, respectively. Since the selected group of hypothetical turbines indicates strongly that the steam plant operating conditions would be 400 psi, 700 F TT, these conditions have been used. Average annual exhaust pressure was assumed to be 1.5 in. Hg and fuel cost was taken at $0.15 per million Btu. This assumption places steam cost at approximately $0.255 per 1000 lb. Established modern turbine performance data have been used in determining steam plant fuel costs shown in Table III.

From this table it is apparent that a small annual saving in fuel cost can be realized.

Load Growth

Not apparent from this table (III) is the effect of load growth. Certainly the investor and utility administrator will want to know reasonably well what to expect in the future. The customary load growth study is not included herein. Substituted therefor is a series of studies for 20, 40, 60, 80, and 100 per cent increase in demand. Load factor is assumed to be constant. Rather than repeat the comprehensive studies used as a basis for the initial studies (Tables I, II, and III), it is believed sufficiently accurate to explore the future in terms of an "average" or typical week. A week in early May was selected and in view of ratios of generation and certain other noted comparisons, it was decided to correlate average week to annual operations on the basis of a ratio of 54.8 to 1.0.

Table IV shows for each of the two types of plant the hours of service rendered by each unit by days. Corresponding generation of energy is recorded. Fuel costs have been derived as previously explained and are stated in terms of weekly costs, weekly differences and annual differences. The $1,300 saving of Table III has become $1,585 in Table IV. This represents a discrepancy of some 12 per cent but does not alter the general pattern of results.

Tables V and VI show similar results for years of greater loads.* Several points are noteworthy. The addition of the 3000 kw Diesel will defer by about two years the installation of additional turbo-generators. This naturally alters the units used in the two comparative plants so that the same sizes of units are not necessarily considered. For instance, in Table V the plant with the Diesel unit has but one 15,000-kw turbo-generator whereas the strictly steam plant has two such units. In no case is the annual saving in fuel cost lower in the higher load years than it has been found in the study of year 1945-46. On the other hand, in no year does the reduction in fuel cost appear to be highly attractive. About three per cent is the maximum saving indicated.

All-inclusive conclusions are not permissible except to the extent that these data illuminate a possible pathway.

Diesel Not Peak Load Unit

It is erroneous to consider the Diesel unit as a peak load unit. Depending upon the relations between steam and Diesel unit capacities, the extent of peak load, and the necessary operating schedule, the Diesel may or may not be used during the peak period. On the other hand, it may be used for one or more hours both morning and evening to change the operating schedule of turbo-generators to obtain vastly improved operating load factors of individual machines. If saving of fuel, plant economy, and improved operating schedules are wanted, then it would seem that the Diesel unit has an excellent opportunity for additional service.

Operating schedules used in these studies are rigorous and presume intelligent interpretation of operating conditions followed by decisive action. These studies contemplate minimum rolling reserve capacity and the use of generating units to attain this condition. Allowance has been made for week-end inspection of large units with smaller units economically handling the lower loads of the week-end. If the steam plant system contemplating installation of Diesel unit does not adhere to a similarly rigorous schedule, then there is little, if any, benefit to be gained by installing a Diesel unit.

Diesel Must Play Assigned Role

Once installed, the Diesel unit must be permitted to play its assigned role. The Diesel unit can be started or stopped with little effort. It can be used successfully for short periods of time, periods which steam practice would rightly consider too short for changing turbines. It is necessary, if the Diesel unit is to be successful, to educate the operating staff in the possibilities and results of this different mode of operations.

Comparative fuel costs and kindred items used herein are not universally

*Editor's note: In his original paper, Mr. Kirkwood had tables with increments of 20% increase from 100 to 200%. Since the two tables presented here show the trend, and to save space we have eliminated the tables for 120%, 160% and 180%.

TABLE III
COMPARISON OF ANNUAL FUEL COSTS

1945—With Diesel:					
Unit	5	5	10	D	Total
Hours in Service.....	695	5,065	6,792	3,630	——
Avg. Hourly Load, kw	4,930	4,920	8,450	1,360	——
Fuel Cost/Hour	$11.80	$11.80	$ 19.90	$ 4.10	——
Fuel Cost/Year	$ 8,200	$59,800	$135,000	$14,800	$217,800
1945—Steam Only:					
Unit	5	5	10	10	Total
Hours in Service.....	1,356	2,308	3,871	7,344	——
Avg. Hourly Load, kw	3,180	4,100	6,010	7,290	——
Fuel Cost/Hour	$ 7.70	$ 9.90	$14.70	$ 17.60	——
Fuel Cost/Year	$10,400	$22,900	$57,000	$129,000	$219,100
				Difference per Year	$1,300

TABLE IV
COMPARISON OF TYPICAL WEEK (OUTPUT BASED ON YEAR 1945)

	Hours in Service						Kwh Generated					
Day	*5	5	10	10	D	Total	*5	5	10	10	D	Total
Wed.	0	8	0	24	9	41	0	40,000	0	205,400	12,900	258,300
Thur.	0	9	0	24	10	43	0	45,000	0	204,400	11,300	260,700
Fri.	0	8	0	24	6	38	0	40,000	0	201,100	6,100	247,200
Sat.	11	15	0	12	8	46	55,000	67,300	0	91,000	9,300	222,600
Sun.	2	24	0	0	19	45	10,000	118,300	0	0	27,500	155,800
Mon.	0	17	0	17	13	47	0	84,600	0	159,900	10,500	255,000
Tues.	0	8	0	24	8	40	0	40,000	0	201,100	10,600	251,700
Total	13	89	0	125	73	300	65,000	435,200	0	1,062,900	38,200	1,651,300
Average							5,000		0	8,500	1,210	——
Cost per hour							$12.05		0	20.05	3.80	——
Cost per week							$156		0	$2.510	$278	$3,994

	5	5	10	10	Total	5	5	10	10	Total
Wed.	0	0	15	24	39	0	0	90,000	168,300	258,300
Thur.	0	0	15	24	39	0	0	90,000	170,700	260,700
Fri.	0	0	15	24	39	0	0	90,000	157,200	247,200
Sat.	2	16	0	22	40	7,000	80,000	0	135,600	222,600
Sun.	24	24	0	0	48	77,900	77,900	0	0	155,800
Mon.	7	8	15	16	46	18,900	20,500	107,800	107,800	255,000
Tues.	0	0	15	24	39	0	0	90.000	161,700	251,700
Total	33	48	75	134	290	103,800	178,400	467,800	901,300	1,651,300
Average						3,150	3,700	6,250	6.750	——
Cost per hour						$ 7.80	$ 9.10	$15.20	$16.30	——
Cost per week						$257.00	$436.00	$1,140	$2,190	$4,023
Difference per week										$29
Difference per year**										$1,585

*Note: In all tables generators are rated in megawatts. "D" is symbol for 3000 kw Diesel generator.
**Note: Based on ratio of kwh generated at 54.8 to 1.0.

TABLE V
COMPARISONS OF TYPICAL WEEK (OUTPUT 140% OF 1945)

	Hours in Service						Kwh Generated					
Day	5	10	10	15	D	Total	5	10	10	15	D	Total
Wed.	0	0	8	24	4	36	0	0	48,000	307,000	6,900	361,900
Thur.	0	0	9	24	5	38	0	0	54,000	305.500	6,500	366,000
Fri.	0	0	8	24	3	35	0	0	40,000	302.500	3,500	346,000
Sat.	11	0	15	12	8	46	55,000	0	120,000	130,500	)6,600	312,100
Sun.	0	0	24	0	15	39	0	0	210,800	0	7,600	218,400
Mon.	0	0	17	17	3	37	0	0	102,000	251,700	3,800	357,500
Tues.	0	0	8	24	4	36	0	0	48.000	296.300	8,200	352,500
Total	11	0	89	125	42	267	55,000	0	622,800	1,593,500	43,100	2,314,400
Average							5,000	0	7,020	12,800	1,030	——
Cost per hour							$12.05	0	$16.90	$29.80	$3.45	——
Cost per week							$133	0	$1.500	$3,730	$144	$5,507

	10	10	15	15	Total	10	10	15	15	Total
Wed.	0	0	15	24	39	0	0	150,000	211,900	361,900
Thur.	0	0	15	24	39	0	0	150,000	216,000	366,000
Fri.	0	0	15	24	39	0	0	150,000	196,000	346,000
Sat.	16	12	0	12	40	96,000	85,600	0	130,500	312,100
Sun.	24	12	0	0	36	157,000	61,400	0	0	218,400
Mon.	6	0	17	16	39	42,700	0	170,000	144.800	357,500
Tues.	0	0	14	24	38	0	0	140.000	212.500	352,500
Total	46	24	76	124	270	295,700	147,000	760,000	1,111,700	2,314,400
Average						6,450	6,150	10,000	8.950	——
Cost per hour						$15.70	$15.00	$24.00	$21.60	——
Cost per week						$723	$360	$1,820	$2,680	$5,583
Difference per week										$76
Difference per year										$4,160

TABLE VI
COMPARISON OF TYPICAL WEEK (OUTPUT 200% OF 1945)

	Hours in Service						Kwh Generated					
Day	10	10	15	15	D	Total	10	10	15	15	D	Total
Wed.	0	0	16	24	4	44	0	0	192,000	316,200	8,400	516,600
Thur.	0	0	16	24	5	45	0	0	192,000	322,000	7,400	521,400
Fri.	0	0	15	24	3	42	0	0	180,000	309,000	5,400	494,400
Sat.	12	17	0	12	10	51	114,800	156,000	0	156,400	18,000	445,200
Sun.	13	24	0	0	8	45	78,000	218,400	0	0	15,200	311,600
Mon.	0	8	14	18	10	50	0	72,000	168,000	255,400	10,600	506,000
Tues.	0	0	16	24	2	42	0	0	192.000	309,000	2.400	503,400
Total	25	49	77	126	42	319	192,800	446,400	924,000	1,668,000	67,400	3,298,600
Average							7,720	9,010	12,000	13,250	1,610	——
Cost per hour							$18.50	$21.10	$28.00	$30.70	$4.70	——
Cost per week							$464	$1 035	$2,150	$3.870	$197	$7,716

	10	15	15	15	Total	10	15	15	15	Total
Wed.	8	0	18	24	50	48,000	0	216,000	252,600	516,600
Thurs.	8	0	18	24	50	48,000	0	216,000	257,400	521,400
Fri.	8	0	18	24	50	48,000	0	216,000	230,400	494,400
Sat.	0	0	18	24	42	0	0	216,000	229,200	445,200
Sun.	10	24	0	0	34	60,000	251,600	0	0	311,600
Mon.	8	0	18	24	50	48,000	0	216,000	242,000	506,000
Tues.	8	0	18	24	50	48,000	0	216.000	239,400	503,400
Total	50	24	108	144	326	300,000	251,600	1,296,000	1,451,000	3,298,600
Average						6,000	10,500	12,000	10,100	
Cost per hour						$14.70	$24.90	$28.00	$24.00	
Cost per week						$735	$598	$3,025	$3,470	$7,828
Difference per week										$ 112
Difference per year										$6,140

applicable. They must be determined for each project and the comparative values may in themselves write the decision.

A system with a very high load factor has less use for Diesel assistance than one with a medium or low load factor.

In judging the value of Diesel assistance, it should be borne in mind that its effect on plant firm capacity is as important as the affect of any other unit. This value is in addition to any fuel saving that may accrue.

There are and, will continue to be, many systems where a Diesel unit can be helpful. Properly applied and operated, the unit will pay dividends

About the Author

Prior to his association with Burns and McDonnell Engineering Co., of Kansas City, Mo., Mr. Kirkwood was with Wood and Weber, Inc., Consulting Engineers, of Denver, and the Light and Power Dept., City of Colorado Springs, Colo. He received his A.B. Degree in Mechanical Engineering from Stanford University in 1923, traveled across the continent for graduate study at Massachusetts Institute of Technology, and received his Master's Degree in Electrical Engineering there in 1924.

Writing is the author's hobby, as are gardening, bowling, and, as he jokingly puts it, "two sons who are rapidly ceasing to be hobbies." One is a graduate electrical engineer, now an ensign in the Navy, and the other a budding aeronautical engineer.

Mr. Kirkwood is a member of both the ASME and the AIEE, and past president of the Engineer's Club of Kansas City. He has written many articles for POWER PLANT ENGINEERING on both steam and Diesel power plants, and in this article he uses his extensive knowledge of both to show how the two types of prime movers can be effectively used in the same plant.

Springdale Turbine

(*Continued from page 83*)

heater water-level measurement is made by a Hagan pneumatic water-level transmitter providing the primary measurement for the Bailey control. For controlling the by-pass on the high-pressure pumps, contacts in the Bailey feedwater pump meters open and close air-operated valves at pre-determined rates of flow. A 21,000-gal condensate storage tank is connected to the condensate system between the air ejector and the low pressure heater. Deaerator pressure is too high to permit this tank to float on the line. In order to maintain deaerator water level, a Bailey condensate control was installed which automatically passes condensate to either the deaerator, the roof tank or recirculates to the condenser.

The
PRACTICAL ENGINEER and ELECTRICIAN
ANDREW W. KRAMER, EDITOR

Magnetic Map Making

We have just finished reading about the Magnetometer, a tricky device which is trailed behind an airplane to record automatically the geological characteristics of the area beneath it. It is dubbed a "doodlebug"—for why, we haven't been able to discover—but even that doesn't seem to detract from its effectiveness. According to the Naval Ordnance Laboratory, which developed it in cooperation with Bell Telephone Laboratories, it was used extensively during the war to detect submarines and is being used in peacetime to discover new mineral deposits and potential oil fields.

According to scientists now engaged in mapping operations in Alaska the doodlebug provides a rapid method for preliminary exploration and also gives a more accurate appraisal of the geological structure of the area than that obtained by ground parties using conventional magnetic methods.

More exciting than all this, however, to a shallow mind such as ours, is the possibility that the doodlebug may be employed in searching for some $22,000,000 in sunken treasure now lying somewhere at the bottoms of the Great Lakes. It seems that some comfortable portion of this vast wealth is wrapped up in 310 barrels of well-aged whiskey. Just what kind of magnetometric didoes are cut by the device when it is approached by a case of Scotch the report fails to mention.

One boon, as yet neither realized or dreamed of, is the possible elimination of cartoons about the lost collar button.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
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How to Weld with Small Welders

Here are instructions on the use of the small welders which have made their appearance lately. Preparing work . . . Precautions to avoid fire and burns . . . How to strike the arc . . . Points to remember . . . Positions for welding . . . Flat welding

By **A. H. HEMKER** General Electric Company

BEFORE you consider striking an arc with your small welder there are certain preliminary steps which must be taken to assure good welding and personal safety. These practices and precautions will soon become habitual, but until they do they should be carefully remembered.

Make sure that the ground cable on your welder is clamped securely to the work to be welded. Locate the welder away from material which might become ignited by sparks from the welding, and keep it high enough off the floor to permit a flow of cooling air through the base.

Clean the work to be welded by wire-brushing it until the loose scale, excessive rust, or paint have been removed. Wear clothing that is fairly fire-resistant and which leaves no exposed skin to be sun-burned by the arc rays. Weld in a spot where neither people nor animals will get flashes from the arc in their eyes. Wear leather gloves so that you can handle hot metal for a brief period without getting burned.

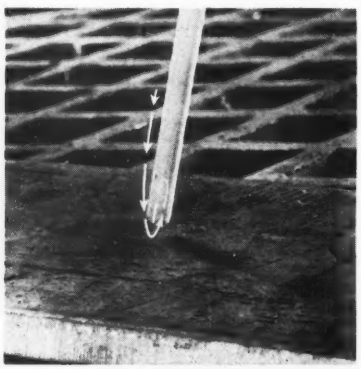


Fig. 1. How to strike an arc. Electrode is bounced off the work and then returned to proper arc length; the arrow depicts direction of motion

Never put an electrode in a holder near grounded work when the welding machine is turned on without having a shield ready to swing over your face. To load an electrode into the holder, insert the bare end of the rod and make sure a tight connection is made. If the electrode coating does not extend completely to the end of the steel at the striking end of the electrode, clip or grind off any bare wire back to the coating.

Now you are ready to start welding. Beginners will find that it is easiest to start an arc and weld with ⅛-in. electrodes. With one hand, point the end of the rod to the spot at which you want to start the arc. After swinging the shield over your face, hold the electrode about ¼ in. from the work, and then twist the wrist to make the end of the rod lightly scratch the work (as in striking a match only slower and with less pressure).

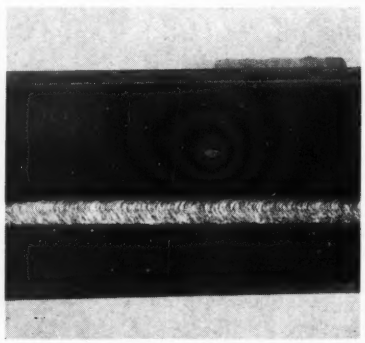


Fig. 2. This photo shows the appearance of a correctly made fillet. Note that fillet contour is practically flat

Another way to strike an arc is to bounce the electrode off the work not more than ⅛ in. (similar to a chicken pecking corn) and then hold steadily, and you will have an arc between the rod and the work. (Fig. 1.) If the arc is started with this bouncing or pecking motion, rather than a direct strike, sticking of the electrode to the work should not be a problem.

Fig. 3. Two-layer fillet correctly arc welded in flat position showing good penetration and contour obtained with proper technique

If the rod does stick to the work, however, twist the rod and holder to break it free. If it does not break free, let go of the holder and switch off the welder, leaving the rod stuck to the work. It may now be broken free easily.

The length of the arc should be roughly the diameter of the electrode with its coating, but not more than ⅛ in. You will soon find that the arc has a certain frying sound when it is running smoothly and laying a good weld. Most experienced operators judge arc length by sound.

You must keep your eye on three points when welding:

(1) Watch the space between the end of the rod and the work. Too much space causes excess spatter and too little space may make the rod stick to the work.

(2) Watch the crater. The shape of the crater (the pool of molten metal) should be symmetrical.

(3) Watch ahead of the rod in order to closely follow the joint being welded.

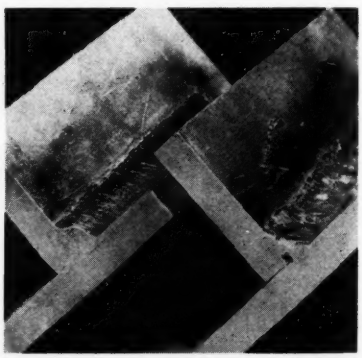


Fig. 4. Fillet welds are shown here after being cut across. The weld on the left was made with correct arc length while the weld on the right has gas and slag inclusion

Welds may be made in any position. A flat weld is one in which the surface of the bead (deposited weld metal) is horizontal. A horizontal fillet (Fig. 2) is one in which one plate is vertical, the other horizontal, and the bead surface itself makes an angle of about 45 degrees with the horizontal plate. (Fig. 3.) Generally speaking, you should hold the electrode so that it points directly into the joint to be welded. Then slant the electrode forward about 15 degrees in the direction of travel and maintain this angle while welding. In welding horizontally across a vertical plate, the electrode should be level and slanted about 15 degrees in the direction of travel.

For consistently good welds, the bead of deposited metal should be

about 1 in. long for each inch of rod used. This is done by holding a consistent arc length, moving steadily in the direction of travel, and feeding the rod down as necessary to maintain the correct arc length. (Fig. 4.) It is quite natural to co-ordinate these two movements after a small amount of practice. The form of the crater (molten pool of metal under the arc) is a good indicator of how the weld bead is going. If it stays

Fig. 5. Correct appearance and location of layers in a three-pass fillet weld

uniform and you can see the metal flowing back of this pool to form ripples, the bead is sound and consistent.

Flat Welding

In plate or thick material (¼ in. thick or greater) where a bond of real strength is required, a weld consisting of more than one bead is necessary. This is called a multi-pass weld. The crack or joint is grooved out with a diamond point or cape chisel, or a grinder, so that it is uniformly beveled (slanted) on both sides. The first pass (bead) is laid at the bottom of the V in the same manner as previously described. The slag should then be chipped from the bead (weld), and it should be wire-brush cleaned. The next bead should be at one side, overlapping the first bead a little more than halfway, with the electrode tilted slightly toward the side of the V. This should also be chipped clean and wire-brushed, and the other, or third bead, laid in a similar fashion on the opposite side to make a practically flat bottom in the V. Carefully cleaning between welds, additional layers are laid in the same manner, overlapping each bead about 50 per cent from one side of the V to the other, until the final layer of beads is flush with, or slightly above the surface or top edge of the V-groove. This is known as a multiple-bead joint. (Fig. 5.)

An easier, faster, and equally satisfactory way is the so-called "stringer, chaser, and weave." The weld is started with a bead at the root of the V, this weld being called the stringer. After removing slag and cleaning, the chaser is laid by starting the arc on one edge of the stringer bead, carrying it straight across to the same position on the opposite edge of the bead, hesitating there briefly, and then going back across the bead to the starting point, where another brief pause is made to permit the metal to wash up and "wet" the parent or work metal. The chaser is continued in this fashion, moving slightly forward each time across the stringer beads. When the slag has been removed from the chaser and it has been wire-brushed clean, the weave bead or beads required to bring the weld flush with the top of the V are deposited in the same manner.

In making multi-pass welds, the importance of thoroughly cleaning off the slag between passes cannot be overemphasized. Any slag left on the bead is liable to be trapped in the final weld, and may cause the weld to fail in service. In any case, some strength will be lost.

Vertical Up-Welding

To weld a seam that is vertical or nearly so, start at the bottom of the V or joint with the electrode pointed slightly downward from the horizontal and hold the arc at that point long enough to form a little shelf. Move the arc quickly up the joint a fraction of an inch, and before the color fades out of the shelf, bring the arc back down again to it, so that the electrode is either horizontal or pointed just slightly upward. Continue this speed upward the same as when welding a flat bead, but watch carefully that the bead does not get too hot and start sagging. If this starts to happen, move the arc rapidly up the seam a small fraction of an inch, and allow the weld metal to cool slightly before bringing the arc back to the bead. This is known as whipping. If it is found easier, whipping may be practiced continuously when welding vertically upward. The upward movement should be quite short (¼ to ⅜ in. uniformly timed), and the arc should return to the crater as the color fades in toward the center. The pause at the upper

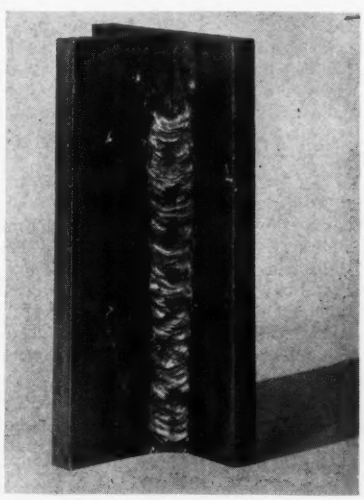


Fig. 6. Single-pass fillet weld incorrectly made in vertical position. The surface porosity was caused by too fast travel of the electrode

end of the bead should be from two to three times as long as the time of the whip when whipping continuously. (Fig. 6.) The weld will be of better quality if it is possible for the operator to lay the bead without whipping except near the top where the metal is getting very hot. When laying vertical-up welds, the current setting on the welder should be somewhat less than that used in flat or fillet welding, and the bead width should be limited to twice the electrode diameter. This, of course, refers to stringer or single-pass beads. Perhaps a helper can assist in adjusting current while you are doing your first overhead and vertical welding. In vertical fillet welds, the leg, or distance up on each plate from the bottom of the joint should be equal on both sides. If this weld cannot be made in one pass, it is made in a similar fashion to the multi-pass joints described previously for V-prepared plates.

Overhead Welding

For overhead welding, the electrode should point upward from the holder and lean slightly in the direction of travel. The current should be somewhat less than normal for the size rod used and the arc should be held somewhat shorter than usual. At first, whipping will probably be found necessary before solid beads can be laid, but otherwise, welding is done the same as in any other position and overhead joints of any type may be welded in the usual manner. It is advisable to get behind the arc and slightly to one side of it while welding roughly in the direction that you are facing. Such a position will not only aid in obtaining straight beads, but will also reduce the quantity of spatter and sparks falling on the operator. If much overhead welding is to be done, the wearing of a cape or overhead jacket is recommended to prevent being burned by the falling sparks. Welds should be practiced on scrap plates and broken to determine their soundness.

Valve Standards

Printed copies of Simplified Practice Recommendation R219-46, Automatic Regulating Valves, are now available, according to an announcement of the Division of Simplified Practice of the National Bureau of Standards.

Automatic regulating valves are used in industry for controlling the temperature, pressure, level, or rate of flow of fluids. The purpose of the recommendation is to establish as a useful standard of practice a simplified list of pressure ratings and sizes of seven types of these valves, made of steel, iron and bronze.

Printed copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 5 cents each. A discount of 25 per cent is available on orders of 100 or more copies.

Maintenance of Industrial Electronic Equipment—II

This second installment describes in detail preventive maintenance work on vacuum tubes . . . cleaning of tubes . . . adjustment of loose tube connections . . . inspection details . . . eight points in ignitron tube maintenance . . . maintenance of capacitors . . . Inspection details of capacitors . . . Tighten, clean, dry the parts of capacitor

Prepared by WESTINGHOUSE ELECTRONICS COMMITTEE

PREVENTIVE maintenance work on vacuum tubes includes inspection and cleaning. Work on the tube sockets and mountings involves inspection, tightening, cleaning and adjusting. Each of these operations is discussed in detail. Avoid doing work on tubes immediately after shutdown as severe burns may result from contact with envelopes and hot tubes.

Inspect Tube Envelopes

Inspect both glass and metal tube envelopes for accumulation of dirt, and tube connector clips for dirt and corrosion. Watch for tube caps which have been broken away from the cement that attaches them to the glass

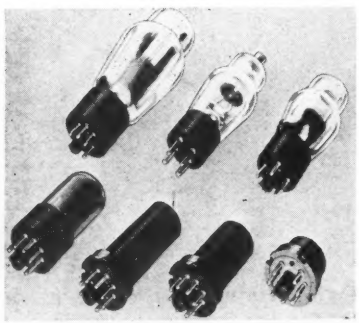


Fig. 1. Shown above are seven different types of vacuum tubes

envelope; also, for tube envelopes that have been broken away from the tube base. When tubes with loose tube caps or envelopes are found, they should be replaced, if possible. If suitable replacements are not available, repair should not be attempted; but a record should be made so that replacement will be made at the earliest opportunity.

Examine Spring Clips

The spring clips that make contacts with the tube caps must be examined for corrosion and for loss of tension with resulting looseness. Also, the condition of the wire soldered to these spring clips must be checked. The wire should be free of frayed insulation or broken strands. The removal of connecting clips from loose grid or plate caps must be done with great care, particularly if signs of corrosion exist. Never turn a clip if it is on a loose cap.

The firmness of tubes in their sockets shall be determined by inspection. Make the inspection by pressing the tubes down in the socket and testing them in that position—not by partly withdrawing the tubes and jiggling them from side to side. Movement of a tube tends to weaken the pins in the base and unnecessarily spreads the contacts in the socket and trouble will occur where it did not exist before. It is desirable to inspect the socket of the tubes at the time the tubes are removed.

Tube Precautions

When it is necessary to remove a tube from its socket, especially if it is a high powered tube, great care is needed. A warm tube must never be jarred and connections to the grid and plate caps must always be removed. It is important to store tubes carefully after they have been removed from the socket. They should not be placed on elevated flat surfaces without proper precaution to prevent their rolling to the floor or ground. A hot tube should never come in contact with a cold surface, as breakage of the tube envelope may result.

Tighten all loose connections in the tube sockets or on the tubes. If the connections are dirty or corroded, they should be cleaned before they are tightened. When tightening lock nuts that hold the socket to the insulated bushing, do not apply excessive pressure. Too much pressure will crack the bushing. Socket mountings must be tight at all times.

Clean the tubes only if inspection shows cleaning to be necessary. Tubes operated at high voltages and with exposed plate and grid connections must be kept free of dirt and dust because of possible leakage between grid and plate terminals. In contrast, tubes operating at low voltages, not having exposed grid and plate caps, do not require frequent cleaning. Dirt should not be permitted to accumulate on low-voltage tubes, but the presence of dirt on them is far less important than it is on high-voltage tubes.

Power tubes with radiators should be inspected for accumulation of dust and dirt on the radiator. If dirty, the tube will run hot and may fail. Dirt should be cleaned out with a cloth, a brush or an air hose.

Tubes with water cooling should be checked for water flow or indications of clogging. Interruption of water flow will result in short life.

Filament voltage should be checked at the tube terminals—not at some remote point in the circuit. This is a frequent cause of poor tube performance.

Tubes need not be removed from their sockets for cleaning. Instead they should remain in place. This calls for special care during work on high power tubes with exposed grid and plate caps. The danger of breakage is great.

The cleaning of tubes calls for removing of dust and dirt from the glass or metal envelope. A clean, lint-free cloth moistened with cleaning fluid should be used. As soon as the surface has dried completely, the tube should be polished with a clean cloth. If proper care is exercised, the grid and plate caps may be cleaned with a piece of No. 0000 sandpaper. The paper should be wrapped around the cap and gently run along the surface. Excessive pressure is not needed; neither is it necessary to grip the cap tightly. When tube sockets are cleaned and the contacts are accessible, fine sandpaper may be used to remove corrosion, oxidation and dirt.

Adjust loose tube connections. Adjustment of contact springs must not be made unless inspection indicates clearly that they are necessary. Tube connector clips must not be flattened during adjustment as flattened clips will not make adequate contact with the surface of the tube cap. If the cap is made of a thin metal, it can be adjusted by gently pressing it with the fingers. If it is made of heavy gage metal, suitable pressure can be applied with a pair of long nose pliers.

Ignitron Tubes

Sealed ignitron tubes require very little maintenance but occasional inspection may forestall future troubles. Inspection should include the following points:

1. Check protective devices for correctness of operation.
2. All contact nuts should be tight.
3. The ignitor contact should be firm and located so as to be in no danger of short circuiting.
4. Water connections should be tight.
5. Any parts starting to rust should be retouched with black, heat resisting paint such as G.E. No. BP-1545 or Republic or Sherwin-Williams Smokestack Paint.
6. Check freedom of water jackets

from rust, scale and sludge. This can be done by examining a sample of water coming out of the tube and by probing into water connection with pipe cleaner or wire and sharp-beam flashlight. If sludge is collecting in water jacket, the water conditions are abnormal and must be corrected. (For water requirements see Westinghouse Electronic Tube Catalogue, Data Sheet 86-450.) Tubes may be placed back in service with corrected water conditions after removing sludge as described in Westinghouse publication BE-7856 (Bloomfield Works).

7. If heat exchangers are used, the cooling water quality should be checked periodically according to IL 2794.
8. If an ignitron is to be removed from a set, the water valves should not be closed until load current has been off approximately one half hour. This prevents the building up of pressure in the cooling system due to stored heat in the tube and with no release for the pressure due to the closed valves and the small volume of water to absorb the heat.

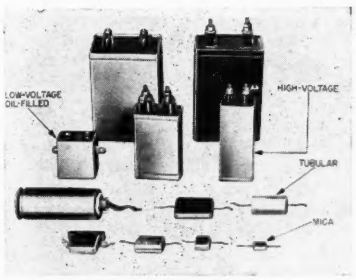


Fig. 2. Several types of capacitors are shown here

Capacitors

Capacitors used in electronic apparatus are made in oil-filled, paper, mica and ceramic types. Work on the capacitors involves inspection, tightening and cleaning.

Before maintenance work is begun, it is necessary for the safety of personnel to short circuit all high-voltage capacitors with a well-insulated grounding stick.

Inspect the terminals of the capacitors for corrosion and loose connections. Wherever high-voltage bushings serve as terminal supports, inspect the gaskets to see whether they are leaking oil. The mountings should be carefully observed to discover loose mounting screws, studs or brackets. Examine the leads for poor insulation and excessive oil, for cracks, and for evidences of dry rot. Frayed strands on the insulation should be cut away. If the wire is exposed, wrap it with friction tape. The terminals of the capacitors should not be cracked or broken. Ceramic and mica capacitors should be inspected for cracks and breaks in the casing.

The case of each capacitor must be thoroughly inspected for leaks, bulges and discoloration. Wherever an oil-filled capacitor is found to be leaking oil, it should be removed and replaced provided, of course, that a replacement is available. Occasionally, a defective capacitor case may be found whose seams are improperly soldered and leaking oil. To retain such a capacitor in the circuit is not wise, but if a replacement is not available, there is no alternative but to locate the leak and resolder the seam. If the seam is resoldered from the outside before an appreciable amount of oil has leaked out, the capacitor may be restored so that it is as good as it was before the leak occurred.

Tighten loose terminals, mountings and connections on the capacitors, whenever they are observed. Tighten the retaining nut on the insulation bushing if oil leakage occurs around the gasket of large oil-filled capacitors. Care should be taken so as not to break the bushing or damage the gasket.

Clean the case of the capacitor, the insulating bushings, and any connections that are dirty or corroded. The capacitor cases and bushings usually can be cleaned with a dry cloth, but if the deposit of dirt is hard to remove, moisten the cloth with cleaning fluid.

Carefully dry the bushings with a dry cloth after they are cleaned. Corroded connections should be sanded with fine sandpaper and then tightened.

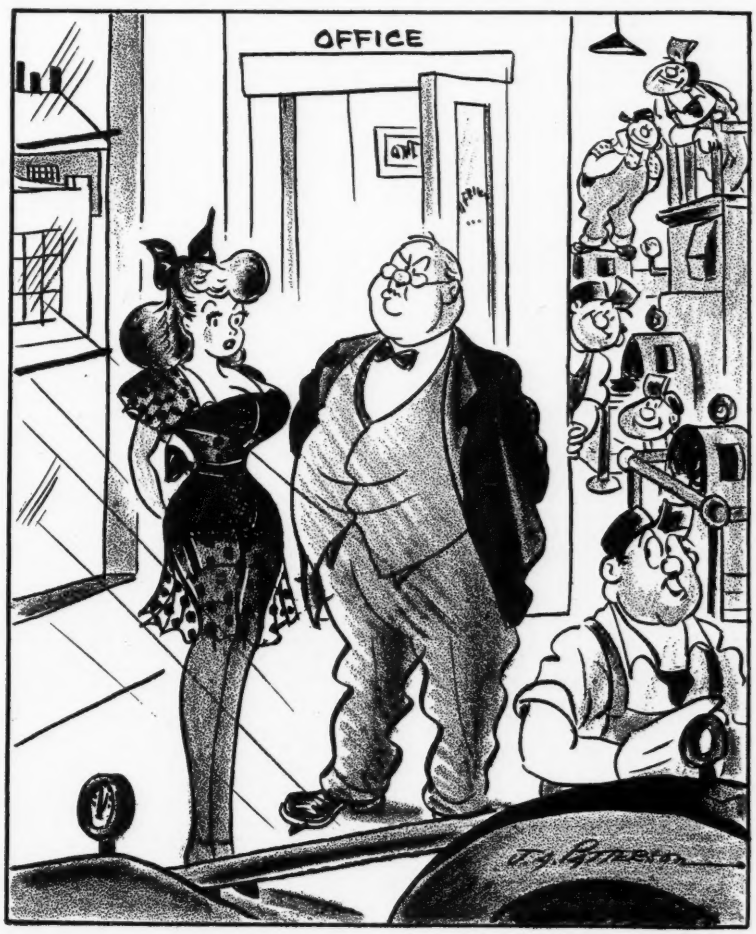
Correction! Alternating Current Made Easy

R. J. McGonegle of Oak Ridge, Tennessee has called our attention to a serious error in the mathematical equation in Eugene George Key's article Alternating Current Made Easy on page 99 of the August issue.

This equation should read as follows:

$$I = \frac{E}{R}\left(1 - e^{-\frac{RT}{L}}\right)$$

This it will be seen is quite different from the way the equation appeared in the August issue. The error, however was not Mr. Key's. He wrote it correctly in his original manuscript. The error occurred in setting the type.



"But, Father, how could I be bothering anybody back here? I'm just watching the big engines."

Small, Fast-Steaming High Pressure Boilers

One operator's enthusiastic appraisal of modern, fast-steaming, high pressure boilers for use in small plants. He shows that such units could be installed to good advantage in many small plants now using obsolete equipment

By GEORGE A. AIKEN

OPERATORS in small power plants often feel that the high boiler efficiencies obtained in the central stations and large industrial power plants lie completely beyond the range of performance obtainable in their own plants. They realize that the high efficiencies are due to the type of equipment installed in the large plants and that such efficiencies are inherent only in large, high capacity equipment.

This, however, is not so. It is possible to build highly efficient small equipment and in the boiler field, there are a number of small units on the market, all built by reputable firms, which although small in size, compare in stability of operation and economy with the large units installed in utility power stations. Because of careful attention to design, their actual installed cost is low enough to make them an attractive investment for the average small power plant.

The type of boiler unit I have in mind, is of the bent water tube design having an upper steam and water drum which extends the full length of the steel encased insulated setting; the lower water drum is of the same diameter, about half as long as the upper drum. Bent tubes connect the upper and lower drums; there is a water wall header on each side of the boiler, which is same length as the setting; at the rear of the headers there are short circulating tubes which connect to the lower drum. The water wall tubes run from the sides of the upper drum down to the water wall headers.

Small Units Will Give Efficiencies Up to 85 Per Cent

These units are being built for pressures up to 650 psi and up to 100,000 lb per hr in capacity. Efficiencies of 80 per cent are common.

There are a number of installations operating at 84 to 85 per cent efficiency at 100 per cent ratings and 82 to 83 per cent efficiency at 200 per cent rating and this without the benefit of economizer or air preheaters.

Some of the advantages of these small, high pressure boilers are as follows: They are completely steel encased and well insulated; the only brickwork is the front wall and bridgewall; furnace walls and roof are water cooled; the water wall header is ideal in preventing clinkers from adhering to the sides of the furnace; the replacement of a few bricks in the bridgewall is about the limit of furnace maintenance; steam capacity in pounds per hr is exceptionally high for a given space; water level is very steady even under heavy overloads; combustion space is ample even with a lower head room than most other type of boilers; very high efficiency regardless of the type of firing equipment; units of 200 to 300 hp can be shipped completely assembled on flat cars to the customer; some are equipped with built-in economizer integral with the boiler, giving low gas temperatures and minimum loss of heat up the stack.

As to fuel burning adaptability, be it underfeed, spreader or traveling-grate stokers; oil; gas or pulverized coal, you can pick your favorite method and be assured that the furnace can be very easily adapted to burn that fuel efficiently.

The foundations are simple and economical in construction; only four concrete piers are necessary, one under each corner, and a concrete mat or floor is all that is needed for the area covered by the boiler. For the larger units concrete walls are necessary, although they need not be elaborate.

The use of a water-cooled furnace exposes a large area of tubes to the heat of the furnace. Tubes that are exposed to the radiant heat in a fur-

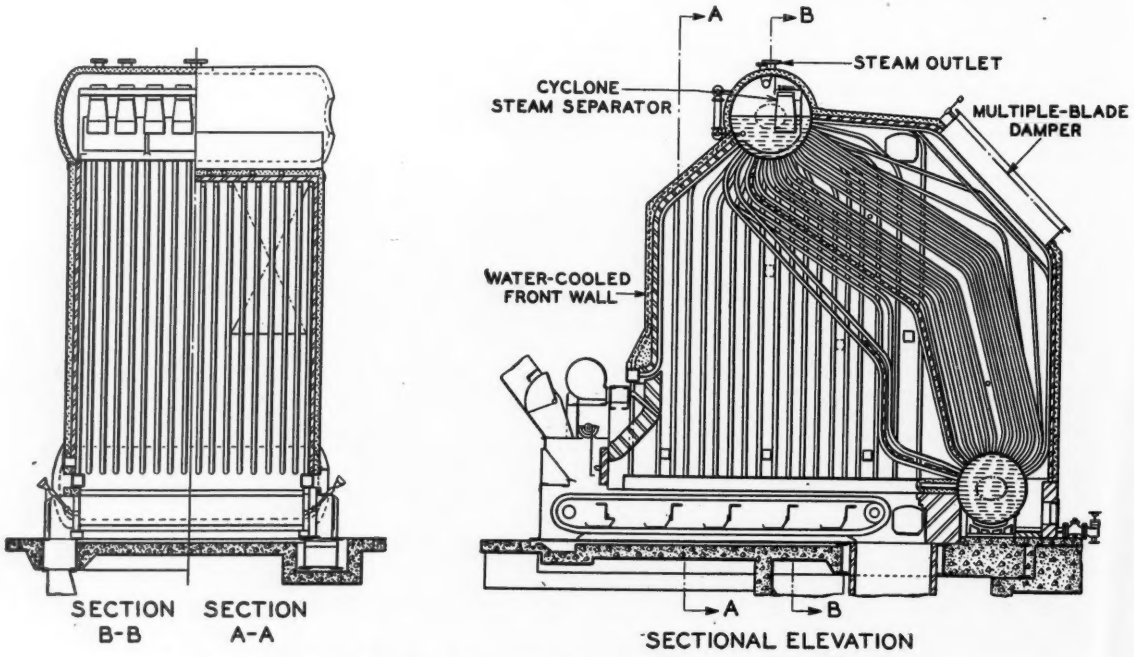


Fig. 1. Sectional elevations of a boiler of the type the author discusses in this article

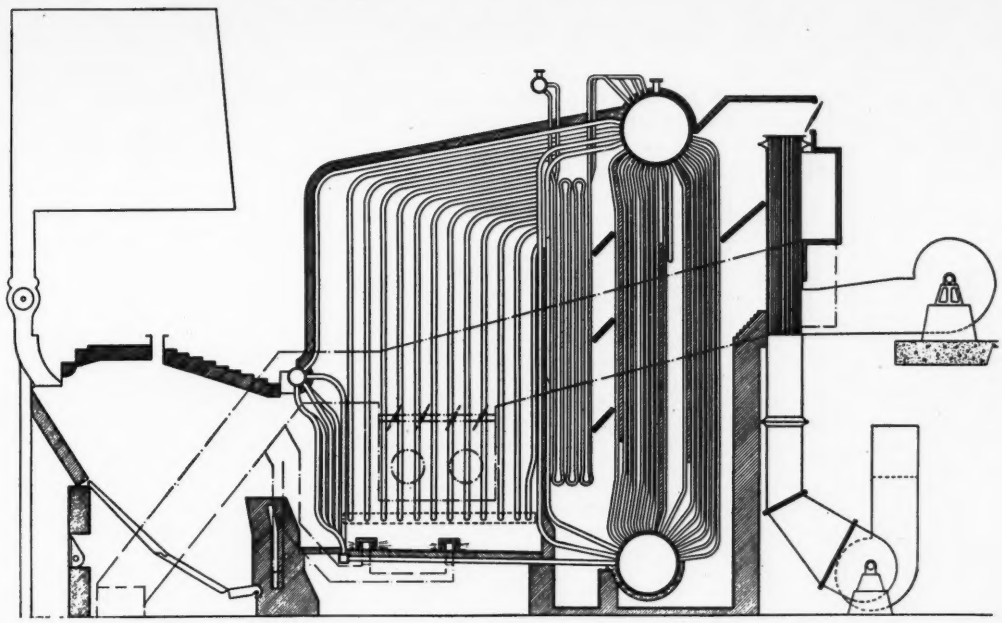


Fig. 2. Cross section of a steam generator for a paper mill, combining oil and gas in the main furnace with auxiliary bark-burning furnace

nace are more efficient as heat absorbers and steam producers than regular tubes over which the gases pass. At least 40 to 50 per cent of the heat absorbed by the unit is effected by the tubes exposed to the furnace. This extensive heat absorbing surface permits operation at high CO_2 while assuring a cool furnace with corresponding low boiler maintenance.

Boiler drums are fitted with manhole plates, some makes are hinged so as to swing into the drum, so as to clear the manhole opening. There is ample room in the drums for the inspection and cleaning or any work needed.

There are handhole openings on the sides of the water wall headers assuring quick and easy access to all lower ends of water wall tubes and parts of the headers. Blowoff valves are located at either the front or rear of the headers according to the designs of the builders.

Soot removal is comparatively easy for the boiler operator. There are usually two soot blowers, which are located in the rear and operated from the operating floor by chains. The bridgewall and baffles protect the elements from the radiant heat of the furnace, thus insuring them of very long life.

Where superheated steam is required, bare tube convection type superheaters can be readily installed to obtain any desirable steam temperature. They are usually placed just back of the bridgewall. The water circulation is rapid and positive; even with a small fire, steam is very easily generated. At our plant, on taking a boiler of this kind off the line for inspection, steam was still being generated with only the remains of a fire in the retorts. Often it is hours before circulations stops.

Could you get any other type of boiler unit of say 30,000 lb per hr capacity of 400 psi into a space 11 ft wide, 25 ft high and 26 ft long? There are a lot of old plants that are limited to headroom that could use this type of boiler to very good advantage. This type of steam generating unit was used in the "packaged type" power plants that filled in a big gap in some of the war-devastated areas of Europe during the war. They did an excellent job, being capable of utilizing a fuel of a type most abundant in and native of the locality they were shipped to.

Units of This Type Used Abroad

It is reported that over 100 of these units were shipped to Russia for installation and a large number of them have also been shipped to China. The U. S. Government purchased 20 or more for installation at Naval Bases.

One plant originally contained six 165-hp vertical fire-tube boilers, fired by single-retort underfeed stokers. It required the combined efforts of two men per shift to care for them and they had no time to spare. Tube, staybolt and furnace sheet repairs were a constant source of trouble.

Two of these boilers were removed and one of these small modern units was installed, having a twin-retort underfeed stoker. This unit has performed splendidly, carrying the entire load easily and has paid for itself in savings on coal, repairs and labor in two years. Since this unit has been in operation, there is only one fireman per shift; cleaning fires, takes ½ to ¾ hour, which includes disposing of the ashes. The greater part of his remaining time is devoted to watching the water, coal feed, pumps, etc. and gives him a lot more leisure.

Typical Installations

Another plant contained two 167-hp boilers of 125 psi having very poor efficiency. One of these old boilers was replaced by a 265-hp 16,000 lb per hr capacity 300 lb pressure, 600 F T T unit having an overall efficiency of 80 per cent. The savings affected were very gratifying.

Another plant in a neighboring town originally contained three 150-hp and one 165-hp water tube boilers, hand fired. One of the 150-hp boilers was removed and replaced by one of these modern stokered units of 16,000 lb per hr capacity and again a big saving was made. After five years operating, the only repairs made were the replacement of about three dozen bricks in the bridgewall.

You can safely install one of these units of the proper size and pressure and be assured of very little outage or trouble. Don't try to save another old boiler in the same boiler room and by doing so, try to get by with too small a unit. If you do, on trying to get more than its designed capacity, you will run into trouble with your stoker burning out castings.

Install reliable feedwater controls; feedwater treatment and combustion control equipment, for this type of boiler will pick up a heavy load quickly and carry it without difficulty if proper controls are installed and proper feedwater treatment provided.

Write to the boiler manufacturers, get their literature and ask for the locations of nearby installations. If you feel that this type of steam generating unit can fit into your post-war picture, visit some of the installations in your own vicinity and see how capable they are.

Unit Heating vs. Radiant Heating

Here is a word of caution and an invitation for some review thinking on the subject of heating industrial establishments . . . Advantages and disadvantages must be weighed in light of past experience . . . Adaptability to change . . . Ease of zone control

By **M. J. DRUSE** Modine Manufacturing Company

IN THE early days of the automobile industry, there were many engineers who predicted that steam would take precedence over gasoline as the motive power for the new horseless carriage. While proponents of each type of engine were quick to champion its respective advantages, the final answer is a matter of record. While this comparison is only partially analogous to the current question of radiant versus unit heating, the eventual outcome will again be found in the record . . . ten to fifteen years from now.

At this writing, the record of industrial radiant heating installations is far too inadequate to mean anything. Performance, installation and operating cost data in volume sufficiently large to carry weight . . . or in volume comparable to that available on unit heater systems is simply not to be had.

The purpose of this article is to review some of the inherent advantages of unit heating which seem to have been lost in the shuffle . . . advantages which have earned for unit heating its present position as industry's standard heating method. As one editor recently pointed out "In the final analysis of any particular installation, the advantages and disadvantages of any particular installation must be weighed against other types of heating **in the light of experienced engineering and practical judgment for the job to be done.**" This being true, the following advantages of unit heating deserve consideration in any comparative analysis of the two types of systems.

Adaptability to Plant Changes

Production areas and plant layouts generally are subject to change and revision. New machines are added, older ones are replaced. New aisles are made; new assembly lines are established. Storage spaces are converted to working areas . . . and vice versa. Changes such as these are frequently accompanied by changes in areas to be heated and in temperatures to be maintained in these areas. For example, relocation of drying or baking ovens, brazing furnaces, etc., invariably set up new comfort heating requirements.

Unit heaters being semi-portable, are easy to relocate or redirect, normally involving only changes in branch supply and return piping and electrical connections. Redirection of heated air stream is even simpler. With unit heaters, the heat distribution patterns are not permanently fixed . . . and, like light distribution patterns, are very flexible . . . easy to change.

Because manufacturing floors are likely to be torn up to accommodate new machinery installations . . . and this means tearing up in-the-floor grids too, overhead unit heaters have a definite advantage here. Interference by steel girders and the possibility that walls, like floors, may be torn out to permit new or re-arranged production lines, discourages location of heating grids in the walls of the average industrial plant. Where there is definite assurance that production areas and machinery locations will not change . . . and where the original heat distribution pattern will always meet future requirements, radiant heating is feasible.

Flexible Zone Control

A unit heater system is analogous to a modern lighting system in its flexibility of control. In fact, no other heating method lends itself so naturally and economically to zone or area control as does a unit heater system. Individually or in groups, like lights, unit heaters can be operated to serve only those specific areas where heat is needed . . . without the necessity of maintaining comfortable temperatures in adjacent areas temporarily not in use. For example, when night shift operations are limited to a few widely separated production areas, only the units serving those areas need be operated. This flexibility of control is also advantageous to quickly counteract variations in heat loss in an industrial plant in cold weather due to high winds or the opening of large doors. Heat recovery in a given area is exceptionally rapid with unit heaters.

While it is true that a good radiant heating system incorporates zone control through the use of circulating pumps, mixing valves, lockshield balancing valves, and immersion thermostats . . . accurate temperature control of zones generally involves a relatively complicated and expensive control system as compared with the simple, inexpensive thermostatic or manual controls used on unit heaters. Even with an elaborate control system, radiant heating can not approach the close and variable control of room temperatures in a zone or in an area within a zone which is possible with unit heaters. This difference is comparable to the night workman who turns on the light directly over his machine instead of lighting an entire bay. (Tomorrow night he may be working on another machine in a different part of the plant.)

In considering claims of fuel saving possible with radiant heating, the fuel required to heat areas not in use, hence not requiring heat . . . should be entered on the debit side of the radiant heating ledger. Only with unit heaters (as explained above) is it possible to so closely coordinate heat distribution (fuel consumption) with the need for heat in a specific area.

With unit heaters, working areas can be warmed to comfortable temperatures within a very short time after the units are turned on. This is especially desirable after week-end shut-downs and eliminates prolonged warm-up periods or operation of an entire grid system (at lower temperatures) over a week-end. Here again, fuel saving should be considered. Unit heaters' quick response (without anticipatory controls) to heat demands caused by sudden changes in outside temperatures deserves consideration in any comparison of the two types of systems.

While the adherents of radiant heating point out that the absence of air circulation prevents distribution of dust in a plant, it is generally recognized that air circulation is desirable for health and comfort. In fact, a very definite number of air changes are usually specified by heating engineers for most industrial heating systems. Unit heater systems can be designed to provide the necessary air changes per hour without the use of supplementary fan equipment.

Tempering and introduction of fresh outside air to meet health codes or individual plant requirements can be handled by unit heaters installed in conjunction with ducts . . . again without separate equipment which would be needed in the case of radiant heating.

A unit heater system can be used to excellent advantage in the spring and summer months by operating only the fans. In this way it is possible to provide well-planned, cooling air circulation throughout an entire plant without the need for installing independent fan equipment at random locations.

In this discussion we have purposely avoided the subjects of warm floors, the making of repairs and replacements to an imbedded system and comparative system costs. There have not been enough radiant systems in industrial plants to provide conclusive data on these controversial points. But speaking positively from experience in thousands of installations over a more than 20-year period, we do know that these present no problem in unit heater systems.

Engineering Progress or World Stagnation—I

Engineering progress determines national economics and trade . . . Without progress in engineering the country dies and its civilization withers . . . Review of Egyptian engineering developments and present state of decay . . . Development in Egypt today result of American Army training of Europeans

By FOURTEEN

THE VASTNESS and productivity of our country tends to cause us to think of all other nations as parallels in 20th Century progress. This is a marked error of conclusion. Inasmuch as engineering development and progress determine national economics and trade, natural resources are a prerequisite to any advancement, hence our country is blessed with all essential elements and skilled manpower to be a world leader. But interlocked in our universal intercourse and enterprise there are many nations in Europe and Asia, much older in history and civilization, than ours, yet today they

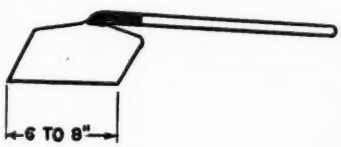


Fig. 1. A combination shovel and hoe used widely in the Middle East for digging and moving of sand or earth

are international parasites which now influence our internal economics and will (even though we like to think we are independent of world policies) help frame our future progress and stability.

World diplomacy and economics are the problems of our professional statesmen and diplomats, but to give the layman a better concept of his counterpart which forms the masses of the other nations let's look at their engineers and developments.

Inasmuch as we are taught our civilization started in mystic, romantic Egypt, there is no better place to start a discussion of engineering advancement than in the disease-infested Valley of the Nile, where the year 1 A.D. meets 1946 A.D.

From an engineering viewpoint Egyptian engineers developed and

Fig. 2. A reed basket used for carrying sand, earth, brick, capacity 25 to 50 lbs when completely filled. (Natives never known to completely fill basket)

left standing tombstones — great pyramids which depict glorious engineering achievements, but with all the blood, sweat and tears they cost, contributed little if anything toward engineering advancement, for with

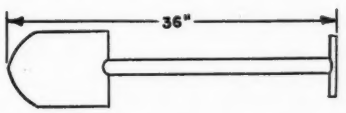


Fig. 3. A miniature round pointed shovel, nearly flat so surplus weight will roll off. A choice of natives when American shovels are available

the death of their builders so died a nation. The famed canal systems, water lifts and engineering science which were wonders of the ancient world, stand today as they were 4000 years ago. Contact with the Egyptians is a grotesque study of a downtrodden, undernourished peoples, whose future ended the day they were born. Homes built of sun-dried bricks, no furniture, sand floors, no sewage disposal, cattle, goats and sheep sharing the same shelters. Water, which would be fatal to an American, is used for all purposes,

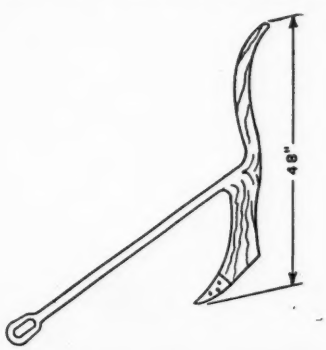


Fig. 4. A plow usually propelled through ground by camel, woman, donkey, horse, water buffalo or any other beast of burden. Can easily be carried by anemic child

yet among all this hell-ridden misery one may see an ultra-modern river dam, power station, machine shop, hotel, automobile or airport. This is almost ironical when one realizes that these suffering people are our neighbors only three or four days from our very doorstep. It is impossible to describe the destitution and nauseating conditions which exist among the 16,000,000 people housed in the narrow Nile Valley.

The stagnation of Egyptian engineering is best shown by the fact

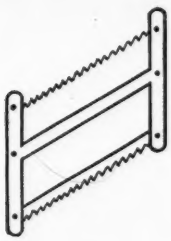


Fig. 5. A middle eastern version of the hand saw. Unique in appearance but a superb tool in the hands of a native carpenter

that every progressive machine shop, power station or enterprise is headed or controlled by a person not of Egyptian descent. Irrespective of many reports published during the war concerning the training of Egyptian civilians in mechanical trades it was basically a "noble experiment" which paid low dividends. In many cases the mind was willing, but the body still desired rest from the ordeal of building the pyramids. With very few exceptions, the craftsmen who were exposed to engineering and mechanical work with success were transplanted Europeans or close descendents of peoples of the Western world. Glowing accounts of American technique used in schooling Egyptians hit some of our leading publications, but European and Sudanese names dominated the upper brackets of the pay rolls.

Egypt today stands as a decaying monument to engineering achievements. It is doomed by insufficient food, damned by the lack of natural resources, cursed as a cross-road of warring nations, and slowly burning into obscurity and racial strangulation because engineering was pushed into the background by religion, hate and refusal to accept modernization.

Your Nose Knows

THE SENSE of smell can be a helpful safety aid in operations involving organic solvents.

A strong odor of solvent in the workroom is a danger signal; it usually means a high concentration of solvent vapors in the air. Workers should therefore be trained to report promptly a sudden rise in solvent odors, or a smarting of the eyes and nasal passages. These are indications that something has "gone wrong," so that excessive amounts of vapor are escaping. Breathing such amounts of solvent vapors may cause serious illness. Moreover, many organic solvents are flammable, so that a high concentration of vapor in the air may be a dangerous fire hazard.

Because organic solvent vapors may

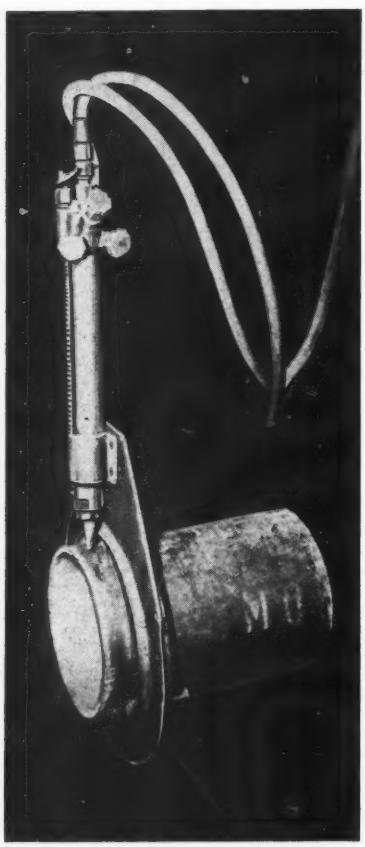
be both a health and fire hazard, solvent-using operations should be carefully controlled, so that the concentration of vapor in the atmosphere is kept to a minimum. Operations may be entirely enclosed, so that no vapor escapes; they may be provided with adequate ventilation, to remove vapors from the atmosphere; or, in certain instances, the worker may be equipped with approved respirators or gas masks.

It is inadvisable, of course, to rely upon the sense of smell as a proof of safety. Odors may not be noticed by men very accustomed to them; sometimes other odors may mask the solvent vapor; also, an atmosphere in which the solvent odor is only barely perceptible may still be unsafe. For these reasons, a periodic analysis of the workroom air, at the breathing level, by a competent chemist is desirable. For some solvents, there are continuous air sampling and recording devices which will help to insure constantly safe atmospheres.—*Safety Research Institute.*

PRACTICAL HINTS AND KINKS

This Attachment Makes Pipe Cutting Easy

IT TAKES AN experienced operator with a steady hand to make a good square cut on pipe. He must follow the line of cut around the pipe, maintain the proper speed and keep the nozzle at the correct distance from the work. With the attachment illustrated here he has only to control the speed. The device guides the blowpipe in a true line and the nozzle is kept at a proper distance from the work.



This pipe cutting attachment, using the Oxweld C-48 blowpipe was easily made from a discarded pipe flange and a piece of sheet steel

The base of the guide is a pipe flange that will easily slip over the pipe to be cut. If the flange is too loose when used on smaller sizes of pipe steel shims can be welded to the inside at three equidistant points. A boss welded to the flange has a set screw to prevent the flange from slipping on the pipe.

A collar cut from a piece of sheet steel is slipped on the pipe flange. The collar should fit so that it can be rotated around the flange without binding and yet not be too loose. Pins welded to the pipe flange prevent the collar from coming off. A blowpipe holder is made by bending a scrap piece of the sheet steel around the blowpipe like a clamp and bolting it to the wide part of the collar.

The guide can easily be adapted to practically any type of blowpipe including hand blowpipes simply by changing the design of the blowpipe holder or clamp.

In operation, the guide is placed on the pipe to be cut, as shown in the illustration. The pipe flange stays in one place while the rest of the attachment is rotated around it. The device works best when used on only one size of pipe.

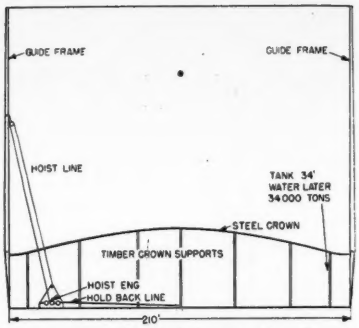
Abstracted from *Tips*, the publication of Linde Air Products Co.

Hoisting Engine Hoists Itself

By H. B. McDERMID

DURING THE erection of large gas holders, as practiced by one construction company, there comes a time when its only electric motor-driven hoisting engine has to be taken from its place inside the huge tank, and made ready for shipment.

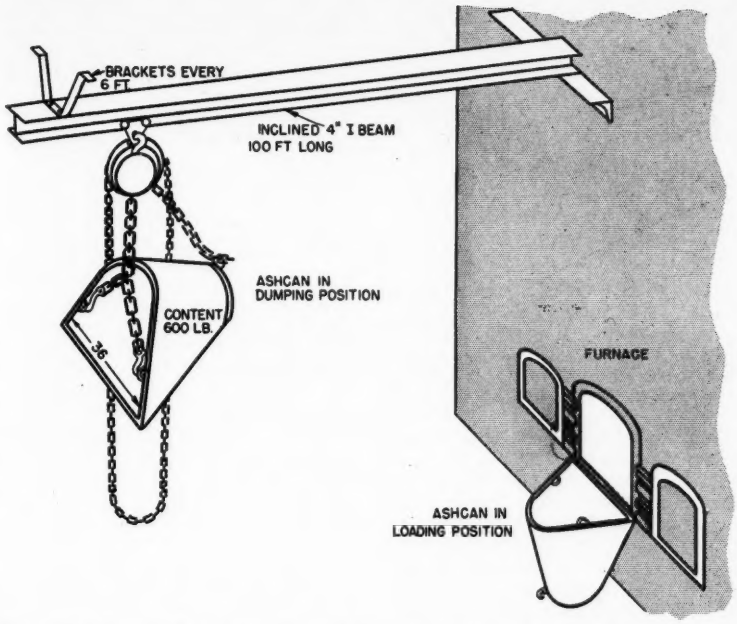
This electric hoist has powered the "tram" cranes which pivot their inner ends in the center of the 210 ft. tank, their outer ends running on a circular track, just inside the circular tank walls. On these outer ends are mounted the hoisting booms, the whole being used during construction to build the big water tank, the side walls of the "lifts," and the heavy "guide frame" that holds the "lifts"



Arrangement for hoisting engine by its "bootstraps"

in place as they travel up and down impounding the varying amounts of gas that the holder may be required to store. When these parts are erected, the "crown," closing the top of the inner "lift" has to be put up, during which process it has to be temporarily supported on top of a heavy framed permanent wooden "crown support" and the hoist's last job, is to erect these timbers.

That done, the next step is to raise the hoisting engine itself, up out of the tank, and there being no other power available, except its own and that of the railroad crane in the yards below, the simplest rigged proposition, is to attach tackle high up on the solid guide frame, reeve the engine's own cable up through the block, and back down to a "bridle" hitch on the engine frame. Then with a "hold back line" from the engine back to an anchorage in the tank bottom (to hold the engine out away from the tank sides) the hoist is ready to start picking itself up some forty feet through a hole left in the "crown support." Electric power is supplied through a long cable as always, and the engineer and a helper ride the load to handle controls and possible emergencies. After a test lift to check the balance of the hookup, the hoist proceeds smoothly, until high enough so that the hole in the crown support can be covered by temporary timbers; then the hold back line is slacked off, allowing the load to swing of its own weight up close to the guide frame, where the railroad crane could reach it when set down and transfer it to the cars below, ready for shipment. The sketch show the set up, which is simple and efficient and needs no further explanation. But it surely does look odd to see that engine climbing up its own cable like a giant spider climbing its web. The only other means available was that of rigging a hitch powered by the distant railroad crane in the yards below, where control would have been through signals only, and the expense and danger and time would have been much increased. Such work as this shows the ingenuity of our steel construction men in the field, operating as they must, with speed and safety, in their effort to beat the other fellow's costs.



This overhead monorail ash hoist was made from some old scrap, I beams and a chain block

Overhead Ash Hoist

By HUBERT ETTELT

This illustration was omitted from the article "How Hal Got Management to Cooperate," which appeared in the September issue of POWER PLANT ENGINEERING, because of space limitations.

THE ACCOMPANYING sketch shows how Hal rigged up an overhead monorail ash disposal system in order to cut down the work and fatigue of Sam, the colored fireman. With this equipment the fireman could remove, at one trip, approximately 600 lb. of clinkers directly from the grating to the outdoor ashpile. The equipment enabled the fireman to get rid of the ashes in one-tenth the time formerly required with the old wheelbarrow.

Motor Bearing End Cap

By THOMAS TRAIL

A tin can lid of the correct diameter, such as used on small paint cans, makes a good emergency substitute for a lost motor bearing end cap. The

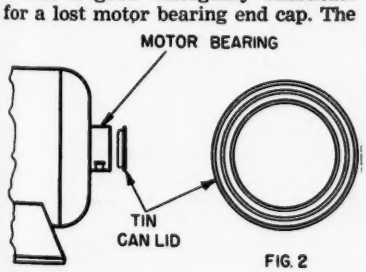


FIG. 2

FIG. 1

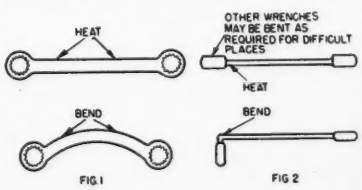
Figs. 1 and 2. Application of tin can lid as motor bearing end cap

tin caps that close the ends of insulated electric conduit bushings also may be used for this purpose.

Half Moon Wrench

By THOMAS TRAIL

In an emergency, when no regular half moon wrench is available to reach bolts or nuts in otherwise impossible to reach places such as automobile starting motor or manifold, a

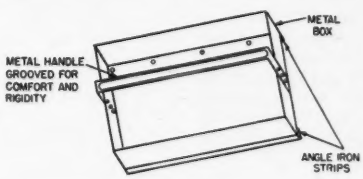


regular box wrench may be heated and bent to the necessary shape. A torch should be used for heating, and care should be taken to avoid drawing the temper from the wrench ends.

Tool Box

Mechanics working around industrial plants will save considerable time if they will carry a suitably sized box with them, in which they can keep various tools and repair or replacement parts they have most frequent need of.

By mounting two angle iron strips on the bottom of the box, as shown, properly spaced to fit a ladder top or step, the box can be placed conveniently within reach of the mechanic when he is working from a ladder, as well as used on any other flat surface at other times.



Engineering "Stethoscope"

THE DOCTOR'S technique has invaded the shops of industry. Turbines in normal operation have little characteristic noise, although tips of their blades may whirl more than 700 miles an hour—faster than sound itself. However, one tip-off that something is wrong inside a turbine comes with a hum, a wheeze or some other unusual noise.

The errant part which causes the noise — it may range from a worn bearing to a "stretched" blade—can be determined by use of a simple formula, the resonance tube, and the engineer's experience. The resonance tube—simply a hollow plunger fitted into a sleeve, and varying in size from six to sixty inches—locates discordant sounds by "tuning in" to the sound's frequency, much as a radio is tuned to the frequency of a broadcasting station. This is done by extending or retracting the plunger, for at any one position only one frequency can be heard.

By measuring the length of the tube at the position at which the noise can be heard, the frequency is determined, and by dividing the known velocity of sound by the frequency, the wavelength of the noise is determined. Wavelengths of "trouble sounds" have been pre-computed and charted, and the particular

Playing medic is William Trumpler, design engineer at the Steam Division of the Westinghouse Electric Corp., who by using a "resonance tube" can determine "ailments" of a steam turbine, just as a doctor examines the human body and interprets the noises brought to him by his stethoscope

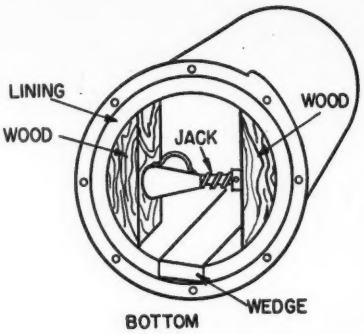
fault of the machine tested is revealed by comparing the determined wavelength with the chart. Since minor repairs may be made without tearing down the whole machine, thus precluding major difficulty, the industrial "stethoscope" saves time and money and assures quieter, more efficient overall performance.

More About Pump Lining

OFTEN THE engineer is called upon to do the almost impossible. Many plants are not equipped with the proper tools to do certain repairs on the auxiliaries. For example, work is to be done on an air pump that has a brass sleeve or lining. The circumference of the lining is 36 in. with the wedge. No tools are at hand to install this lining. The question, "What to do?" is the first thought in the mind of the engineer in charge.

A lining of this dimension is very difficult to install. The writer has seen these linings installed for the past thirteen years and each engineer has his own method of installing them. The pullscrew works well when installing linings if one is at hand.

In this case we were working without the pullscrew. For any engineer having to install linings of this size without the proper tools I would suggest the following:



The sketch above shows the liner after it has been expanded by the jack and the wedge has been driven into place

Remove the old lining with a long cutting bar. Next place the new lining to the proper setting. After the lining is properly set, place a small jack in horizontal position at the center of the lining. Place a narrow strip of wood at each end of the jack so as not to mar the lining. Now expand the lining just enough to allow the wedge to be driven into position. Release the jack and presto, the job is complete.

Philadelphia SAMUEL J. AYLING

LETTERS AND COMMENTS

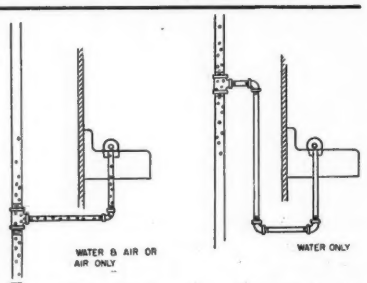
Eliminating Air from the Water Lines

By C. L. SHOBE

I SEE IN the Questions and Answers Department from time to time that air in the water mains is causing the boys some trouble. Since we are pumping our own water with a surface pump into a closed system (no water tower) we have had some of the same trouble. By using a surface pump some air is drawn into the system through the pump packing. Also, some air can be left in the system after passing through regenerating water softeners if care is not taken to purge the air from the softener tanks before they are put on the line again. And if an air pressure system is used some air will be absorbed to be freed later at some point in the line as the temperature is raised.

We still have the air but by gradually correcting the hook-ups in the places causing trouble we have nearly eliminated the inconvenience of its presence (all except pipe corrosion.) I am enclosing a sketch illustrating the difference in hook-ups. As drinking fountains are the greatest offenders I am using them as an illustration.

Figure 1 shows the free air bubbles going up the main. Some of this air passes up toward the valve on the fountain displacing some water which goes back into the main. Obviously this hook-up is incorrect.



The sketch at the right shows how the air bubbles bypass the water fountain

In Fig. 2 the line from the main to the fountain leads off from the main at a point higher than the valve on the fountain. Any air passing along the main stays in the main and the line to the fountain contains a loop of solid water into which no air can enter while the fountain is not in use. With the hook-up in Fig. 1 you will, in time, have a pipe full of air and when the valve is opened you get a squirt of air and water—and a bath.

While the hook up in Fig. 2 is not convenient to make sometimes and requires more space and fittings, we have found that it relieves the air situation around here.

The Pressure Gage That Did Double Duty

By WILLIAM T. MULLEN

WHAT I'M about to tell doesn't refer directly to this question but it does refer to the importance of any and all types of gages as J. R. Darnell mentions in his article on the steam gage.

One part I remember well and that is "Even if the plant was so poorly managed that there was no spare gage, the operators temporarily could have borrowed one from another boiler for a few moments to check the pressure."

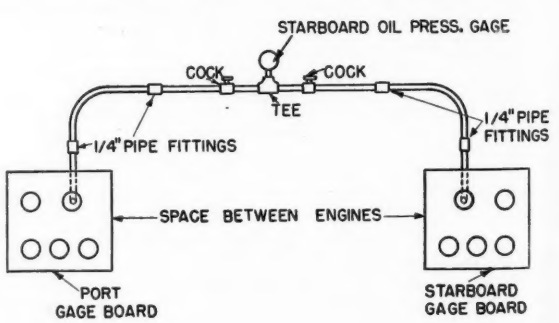
This is just what the average engineer will do if he has been taught to think in emergencies. And I'm glad to see it on paper so that the news will get to many other readers.

This brings to my mind one particular experience of gage trouble some years ago, while an engineer aboard a ship, with twin Diesel engines.

We were three days from home and the port engine lubricating oil pressure gage went haywire. This gage break happened just about 10 minutes before I relieved the engineer, and to play safe the chief engineer was called and this was shown to him.

He told me to go ahead and take over the watch, do the best I could and if in any doubt to shut down this engine. Well you can imagine how I felt not knowing the oil pressure and with the engines running almost full speed.

I intended to get some means whereby I could get a reading and didn't waste any time doing so. As there were cocks beneath the gages it meant that the cock beneath the



The sketch at the right shows how Mr. Mullen hooked up the single pressure gage to do double duty on two engines

broken gage could be shut off and the gage removed. There weren't any spare gages aboard ship, so it meant a double job for a single gage.

So I proceeded to install a 6 in. nipple (¼ in.) and another piece of ¼ in. pipe which was bent so as to extend to the other engine. The sketch can show better than words can tell the story, and this job lasted until we made port where we received two new gages and a new spare gage.

To get the oil pressure reading of the port engine, the starboard engine petcock was closed and the port side petcock was opened. To get the starboard engine pressure reading the procedure was reversed. In this way the worry, as well as a sloppy job, was eliminated. To check the oil pressure every 15 min. meant it has to be done 16 times on a 4 hr watch. So the job was well worth the time and effort.

From a Slab Ice Plant

IT IS A LONG time since you have heard from me. I am now working in what I believe to be one of the very few remaining ice plants making plate ice. I often wonder how those old timers ever kept from going nuts in such jobs. Making plate ice is as different from can ice as day is from night. There is a lot more work to it to produce a ton of ice and time is an important factor. It takes 5 to 6 days to freeze a 10 in. plate. Then it must be hoisted out; Our average plate weighs 3 tons. After hoisting it out you trim it so it lays flat on the tipping table. (If not properly trimmed it breaks.)

Then the table is rolled over so it is flat and the saw cuts this big slab up into smaller cakes. From here it goes to the usual storage and sales. The lifting rods are suspended in the freezing water. They have a removable foot that is separated from the rod by passing a 2500 ampere low voltage current through them and heating them until free; then the rods are unscrewed from the foot and removed and the foot is pulled out the side of the cake. This makes a lot of holes but nobody seems to mind. Freezing is done by having a lot of direct expansion piping in the walls where the cakes are frozen and the cakes are loosened by using hot gas.

R. G. S.

What About Actual Combustion Losses?

YOUR EXCELLENT journal carries notices of various programs of research in the uses of coal. This is welcome news, and I hope that these efforts will not shoot at such lofty objectives that they will overlook some of the much needed simple fundamentals of combustion.

Essential to any substantial progress in the use of coal for steam generation are explanations (from scientific data) for some of the simple observations. For example: some of the most accurate and extensive combustion tests of record were conducted by the U. S. Bureau of Mines. Figure 1 is prepared from that data. For the particular group of tests whose data are plotted at the point indicated by the star, there was 19 per cent of the heat value of the fuel that was never developed. In this case, it was a furnace loss (not an ashpit or fly ash loss). No one knows either from these or any other data, just what happened within the furnace to account for this great loss. No one knows what the real analysis of the escaping gases is in cases of this kind.

Volumes upon volumes have been written about CO losses and how to compute them from Orsat readings. Now look at Figure 2*. Curve "A" is from data from a selected group of good performance tests and shows the furnace losses as computed from the CO readings in the prescribed way. Curve "A'" shows what the actual furnace losses were.

Curve "B" is from data from a selected group of bad performance tests and shows the furnace losses as computed from the CO readings in the prescribed way. However, the actual losses were about 7½ times larger as shown by Curve "B'". The losses as revealed by the Orsat were nominal, seldom over 2 per cent whereas the actual losses were astounding. They revealed well above 15 per cent.

The art of burning coal cannot progress to a scientific stage until these matters are cleared up thru scientific research involving a great fund of check and re-check data. We engineers, working in this art, have devised practical ways of circumventing or bridging these gaps in the scientific knowledge of combustion, but I hope research chemists will soon have the courage to face these problems that we may have the answers.

What is the full and true analysis of these losses? Has anybody the answers? If not, is anyone setting about to find the answers?

Chicago — LLOYD R. STOWE

*These figures are from "The Art of Burning Coal" by L. R. Stowe.

He Files These Pages

THE AVERAGE fellow engineer likes to save some of the valuable information that is contined in POWER PLANT ENGINEERING especially in the Practical Engineer and Electrician Section.

A few weeks ago we were notified we would have to get out of our apartment and that meant making changes that hadn't been made for years, especially where these magazines were concerned. If I had only

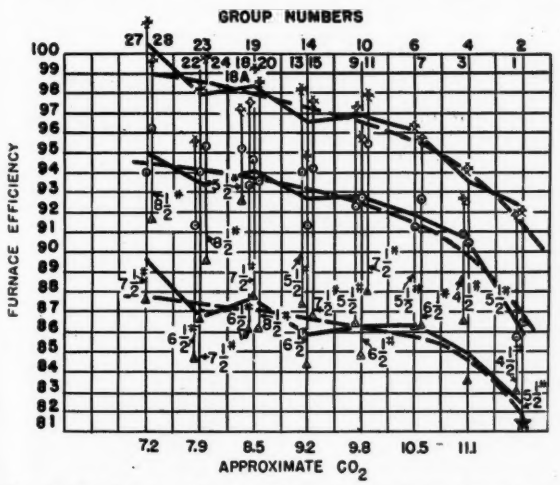


Fig. 1. The data used to plot this chart was obtained from tests conducted by the U. S. Bureau of Mines. Note star in lower right hand corner referred to in text

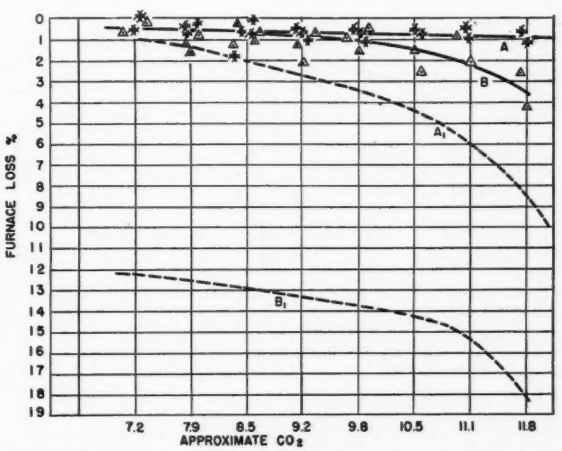


Fig. 2. Curve A in this chart is from data from a selected group of good performance tests. Curve B is from data from bad performance tests

the one magazine stored away the move wouldn't have been too hard, but with four different books saved from the year 1938 you can see it was time for me to make some change.

I just had to save the "Practical Engineer and Electrician" and do it in an orderly manner. So hit upon the idea of putting each month of every year in a folder; each folder contains 12 months of this particular section of POWER PLANT ENGINEERING.

A fellow engineer with whom I used to work some years ago, and who is a namesake of mine (but no relation) was asking me for some pump information. While talking of engineering in general the conversation got around to your magazine. He said he used to get it but due to moving from place to place it meant he had to change his place of residence and in this way, he never got around to subscribing again. I volunteered to let him look over the folders of the past issues and he has made good use of it.

Philadelphia WILLIAM T. MULLEN

Questions And Answers

Question No. 345

Where Should Relief Valves Be Installed on Economizers?

I AM DESIGNING an economizer, which is to be placed on top of the boiler gas outlet. The water inlet to the economizer is at the gas outlet from the economizer and the water outlet from the economizer is nearest the boiler gas outlet.

Is the water relief valve to be placed on the inlet or the outlet end of the economizer? Also, should the stop and check valves be placed between the economizer and the boiler or between the pump and the inlet to the economizer?

Williamsport, Pa. J. W. W.

Question No. 346

How About Vent Valves for High-Pressure Steam Lines?

I WOULD LIKE to have you put me in touch with a firm that can furnish thermostatic valves or some type of valves to install on steam lines to release CO_2 and air that go along with the steam. Some of these would operate at 100 psi and some from 15 psi down. I would also appreciate information as to the proper location and methods of installing these valves.

More Data from C.L.S.

Some 13 years ago I had occasion to do some repair work on a light plant engine at St. Mary's Hospital at Emporia, Kansas.

There were no low-pressure steam lines in the boiler room except to the water heater.

The heating steam was carried to the buildings at full boiler pressure, being cut to 40-50 psi at the point of distribution and further reduced to 2½ psi by the use of another reducing valve.

On this steam main, near the header, as near as I can remember, one of the valves in question was being used. Another one of these was in the highest point on the steam main at the end of the pipe tunnel, where the line entered the hospital building. The line went upward to a height of 10 to 15 ft, with the valve on top and a condensate trap at the lower end of the riser. From the top of the riser the main entered the building.

The engineer there told me the valves were for expelling air from the steam line and that they were thermostatic.

Having since inquired of many people where to obtain them and not being able to find out, I turned to POWER PLANT ENGINEERING.

I also happen to know that they were using 1 to 2 pounds of soda ash as boiler treatment without the usual resulting return line corrosion caused by the CO_2 given off by the reaction of the soda ash in the boiler. I wrote the engineer who was in charge there for further information on those valves but never received an answer.

I do know that they were high-pressure vents and made for the purpose of expelling air or any gas that is cooler than the surrounding steam but have never been able to figure out why an air valve should be placed in the higher places. Since steam is half as heavy as ordinary air it should find the top and the air the lower levels.

Great Bend, Kan. C.L.S.

Editor's Note—Valves for venting air and gases from steam mains can be obtained from a number of manufacturers and in various forms.

A medium-pressure venting valve for this purpose, made by Jas. P. Marsh Corp., is shown in Fig. 1. This is a float-operated valve. The thermostatic element is a volatile expansion diaphragm. It has a vacuum check in the top to prevent the return of air into the system. If it is desired to prevent formation of a vacuum in the system, the check can be removed. The valve is made in one body size with either ⅜ in. or ¾ in. male pipe connection and for pressure ranges up to 125 psi.

Another form of high-pressure air eliminator, designed for working pressure up to 150 psi and supplied by Wright-Austin Co., is shown in Fig. 2. It is designed primarily to eliminate air entrained in a steam piping system; when the steam is shut off, the steam remaining in the system condenses, produces a partial vacuum and air may enter through various parts of the system or connected apparatus. This eliminator contains a non-corrosive expanding element, shown at the right, that closes the eliminator at 212 F and holds it closed until the temperature drops below that point, when it opens automatically. The eliminator will also act as an emergency water discharge valve to relieve a flooded system. The body is nickel-plated cast bronze, bottom inlet shank has ½ in. male connection and ¼ in. female connection; air outlet at top threaded for ⅛ in. iron pipe.

One engineer tells us it is his impression that a Warren-Webster high-pressure type thermostatic trap (Class 3-good up to 150 psi) or a Hoffman Series 50 combination float and thermostatic trap (good up to 125 psi) may have been used in the case cited by C. L. S. Here are comments by leading engineers on this subject:

Vents May Have Been Used for Other Reasons

IT IS MY impression that, in the instance cited, the traps were used for physical reasons, with little or

Fig. 1. One form of vent valve for steam mains

no thought being given to the prevention of corrosion through purging of non-condensable gases.

I also feel it is significant that apparently the traps were located at points where non-condensable gases would be expected to accumulate during periods of little or no flow.

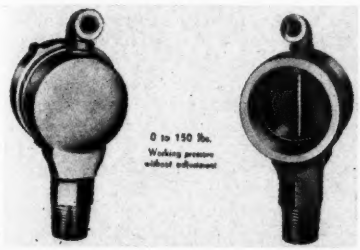


Fig. 2. Exterior and interior views of a high-pressure air eliminator for steam mains

Whether such vents will be of value and, if so, where and how they should be installed can be determined only by a study of the system in question. The densities of the non-condensable gases, with respect to steam, appears to me to be a superfluous consideration.

Detroit, Mich. L. F. C.

Why the Air Is at the Top

C. L. S. SAYS that he has "never been able to figure out why an air valve should be placed in the higher places; since steam is one-half as heavy as ordinary air, it should find the top and the air be at lower levels." The most likely explanation I can offer is that your reader probably has overlooked the effect known as Dalton's law of partial pressures (see page 140 of *Piping Handbook*, 4th Edition).

How this works out depends on the relative amounts of steam and air present in a cubic foot of the mixture flowing through the pipe. Assuming, for example, that the mixture contains 10 per cent by weight of air and 90 per cent of saturated steam, the following example has been worked out for a total pressure of 15 psi g.

Example

Pressure of mixture	
Gage pressure	= 15.00 psi g
Atmospheric pressure	= 14.70 psi
Absolute pressure	= 29.70 psi abs
Partial steam pressure	= 29.70 × 0.90 = 26.73 psi abs
Partial air pressure	= 29.70 × 0.10 = 2.97 psi abs
Total pressure	= 29.70 psi abs

Referring to the steam tables (see page 234 of *Piping Handbook*) the saturation temperature corresponding to 26.73 psi abs is about 244 F and the density 0.065 lb per cu ft.

The density of air under the foregoing conditions can be computed from the "Equation of a Perfect Gas" (see page 144 of *Piping Handbook*) as follows:

$$W = (2.6982p) \div T$$
$$= (2.6982 \times 2.97) \div 704$$
$$= 0.0114 \text{ lb per cu ft}$$

p = partial air pressure = 2.97 psi abs

$$T = 460 + 244 = 704 \text{ F}$$

From which it appears that under these conditions the density of steam is nearly 6 times that of air. If the air tends to separate out from the steam rather than to remain uniformly diffused, it would seem that it should be vented from the top of the system. In warming up a line that was initially full of cold air, however, there might be a period during which the air was heavier than steam.

Where CO_2 or other gases are present, their densities can be estimated by Dalton's law along the foregoing lines, although the problem becomes more difficult as the number of components increases.

Detroit, Mich. SABIN CROCKER
Senior Engineer, Mechanical Engineering Division, The Detroit Edison Company

Question No. 347

What Is "Skin Effect" in an Electrical Conductor?

I HAVE BEEN a steady subscriber to POWER PLANT ENGINEERING for the past three years and have recently signed up for another three. I have found most of the contents of real importance, help and instruction.

At present I am anxious to increase my knowledge of a-c power transmission with both cable and copper bus and would like some information on "skin effect." I have been unable to obtain, from any text book available to me, specific information on this subject.

I know that the shape of a conductor can vary the "skin effect" but whether it is simply because of increased dissipation of heat due to increased radiating surface, or convection by air circulation, I do not know. I have been told that more current will flow through the outer layers of a large stranded or solid conductor. If such is the case, is it because of higher temperature in the inner layers?

I am also informed that the density of current will tend to be greater on the adjacent sides of parallel conductors. If the temperature of a larger circular conductor carrying current, varies across its cross-sectional area, then it would seem to me that the current density in that conductor would also vary. But that does not explain the condition stated concerning the parallel conductors. It seems to be that there may be other factors than the dissipation to consider.

You very kindly gave me some useful and concise help on another electrical matter about two years ago and I thought maybe you would do the same in this case. If you can recommend a good up-to-date text book, not too technical, it will be appreciated.

Jenkintown, Pa. T.W.H.

Editor's Note:—First let us point out that heat or temperature have a bearing on "skin effect" only as they effect conductivity of the wire. They are not responsible for the skin effect itself. The explanation in the *Electrical Engineers' Handbook*, by Pender and Del Mar, goes something like this:

If you think of the conductor as made up of many filaments, each carrying its own portion of the total current, it can be seen that the filament near the center of conductor (being closer together) will be linked by more flux lines than those near the exterior.

If the emf producing the potential gradient (voltage drop) through the wire is an alternating one, the back emf (created by collapsing flux lines or field around a conductor) will be greater in the interior filaments than in those near the surface. Since the potential drop is the same across all filaments, the resistance drops in the internal filaments (because of this back voltage) are less than those in the external filaments.

This can be brought about only by the current distributing itself over the cross-section of the wire in such a manner that the current density in the interior of the wire will be less than at the surface, i.e., the current is forced towards the surface, or "skin," of the wire, hence the term "skin effect."

The self-induced emf depends not only upon the amount of flux set up, but also upon the rapidity of its variations. That is, the faster the field builds up and collapses, the greater the voltage developed. Hence the skin effect will increase as the frequency increases. It also increases with increasing cross-section of the conductor, with increasing conductivity of the conductor, and with increasing magnetic permeability.

At power frequencies, skin effect is not an appreciable factor, except in conductors of large cross-sectional area. In conductors smaller than about 250,000 circular mils cross-sectional area, the effective resistance is practically identical in magnitude to the ohmic resistance.

The increase in current density along adjacent sides of parallel conductors, which you mention, is called "proximity effect," Again, this is not caused by heat or temperature, but by the flux set up by the currents in the two conductors. Current redistribution in one conductor causes further current redistribution in the one adjacent, and the factors affecting proximity effect are essentially the same as those affecting skin effect, but very difficult to explain without using higher mathematics.

A good text that is not too technical is *Practical Electricity* by Terrell Croft, McGraw-Hill Book Co.

Answer No. 333

How Big a Relief Valve for an Engine Cylinder?

Simple: Make Valve Area Same as High-Pressure Exhaust Port

THE GENERAL RULE to determine the proper size safety valve for a cross compound engine receiver is to figure the area of the high-pressure cylinder exhaust port and select a safety valve of equal area. Having exhaust port and safety valve of equal area insures against the receiver pressure building up.

Somerville, Mass. JOHN GROVES, JR.

Answer No. 334

First He Wants the Steam Dry, Then He Wants It Wet—from Same Boiler

Trap Adjustment is the Answer, Says Pef

REDUCING the pressure of steam by means of a pressure-reducing valve will **not** increase the moisture content of the steam, but will have a slightly opposite effect.

If the steam used on pressing machines needs to have some moisture content, the best way to bring this about is not to remove the moisture from the steam by means of traps or otherwise. I assume that each pressing machine has its individual trap, in which case, as soon as the machine is put to use, the trap should be cut out. If this makes the steam too wet, the valve trap can be cracked so that the trap will remove only part of the moisture.

If the 20 pressing machines have a number of traps in common, some of these traps, if not all, should be cut out when the pressing machines are in use.

If the steam is still too dry for pressing, even with all the traps cut out, some of the insulation from the pressing machine steam lines should be removed.

Boston, Mass. N. T. PEF

Answer No. 336

What's Wrong in This Refrigeration Plant?

HE HAD a feeling that there was something wrong in the layout or operation of his refrigeration plant, or perhaps both, said C.O.S. in the June issue. The plant serves a meat-packing firm and consists of two larger compressors and four smaller ones connected to coolers, which they want to keep at about 36 F, and to freezers, which they would like to keep at —20 to —30 F but which they get down to between —5 and —20 F.

Details of the way the compressors are connected to handle this load were given and several questions asked about back pressure—which is usually a few inches of vacuum—use of heat exchangers, advisability of using superheat-actuated expansion valves and so on. Here is some sound comment on the situation by George Holman. He suggests re-connections to form two entirely separate evaporative systems and shows how they could be connected and operated. Following this are some comments by Walter Harvey.

Form Two Distinct Systems, Says Holman

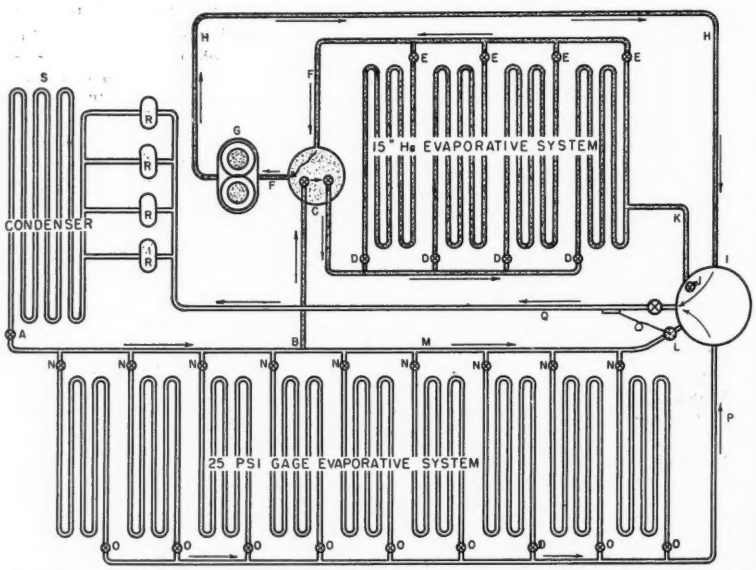
IN THE refrigeration system C.O.S. describes, the basic cause of what's wrong lies in the attempt to maintain subzero temperatures in freezers with the same evaporative system used to maintain above freezing temperatures in a number of coolers. The result is a highly inefficient system, operation of which would be damaging to equipment even if the desired temperatures could be obtained. The system should be changed and operated differently.

As shown in the accompanying drawing, I suggest that C.O.S. form two distinct evaporative systems. One should be laid out to operate at approximately 15 in. vacuum in the freezer evaporators, the other at 20 to 30 psi gage in the cooler evaporators. Assuming it to have twice the capacity of one of the smaller compressors, the larger compressor may be used as a booster to lift the vapor from the 15 in. vacuum in the freezer evaporators to the pressure prevailing in the cooler evaporators. If the largest compressor is not of sufficient capacity, one of the smaller units may be operated in parallel with it.

The comparatively hot vapor from the booster compressor should not be discharged directly into the cooling room evaporators, since it may interrupt the heat transfer processes there. Also, it may produce hammer in the pipes, either by direct impulse, by sudden evaporation of liquid by counterflowing hot vapor, or by sudden expansion of the pipes.

A better method is to discharge the return vapor from the coolers and the hot vapor from the booster compressor into a common vessel of several cubic feet volume, such as a non-heat exchanging accumulator or liquid receiver. Such a vessel (I) should be equipped with a safety valve set to blow back into the freezer evaporators, or to atmosphere or into water outside the plant.

Possibly only one of the four smaller compressors would be needed for the second stage compression of the vapor from the booster compressor. By the arrangement shown, however, any number of them may be used on the system as a whole. In parallel with the others, each compressor would draw a mixture of cold vapor from the cooler system and hot compressed vapor from the freezer system. If the vapor entering the smaller compressors is too highly superheated, it may be cooled by opening one or more of the cooler expansion valves (N — N) until wet vapor returns to absorb the superheat of the freezer system in the mixing vessel (I).



How Holman would connect C.O.S.' refrigeration plant to form two systems and improve operation

A—Master liquid stop valve.
B—Liquid line branch to freezer system.
C—Heat exchanger accumulator of freezer system.
D—Manual type expansion valves of freezer evaporators.
E—Return valves of freezer evaporators.
F—Return line from freezer evaporators to booster compressor.
G—Large compressor used as booster.
H—Hot vapor line from booster to vapor mixing vessel.
I—Mixing vessel. Liquid receiver or non-heat exchanging accumulator.
J—Safety valve on mixing vessel.
K—Line from safety valve to freezer evaporators.
L—Vapor desuperheating thermoexpansion valve.
M—Main liquid line.
N—Manual type expansion valves of cooler evaporators.
O—Return valves of cooler evaporators.
P—Return line of cooler evaporators.
Q—Main return line.
R—Smaller compressors.
S—Condenser.
Arrows show direction of refrigerant flow.

A much better method of reducing the superheat of the vapor entering the compressors is to install a thermoexpansion valve (L) in a liquid line to the mixing vessel, with feeler bulb clamped to the main return line, as shown. These automatic expansion valves should also be used to replace the hand type on all evaporators, both in coolers and freezers. The manufacturers can supply them charged for any specific application. When ordering a valve, temperature of the room in which it is to operate should be given, together with suction pressure, kind of refrigerant and total length and size of evaporator pipes.

Pumping of oil by one of the compressors is probably due to a too-high oil pressure from the lubricator or oil pump. If splash baffles at the bottom of each cylinder are removed, splash-oiled compressors frequently pump oil badly, especially if the oil level is kept too high.

Marissa, Ill. GEORGE HOLMAN

Comments by Harvey

IN THE meat packing plant of C.O.S. I think the first thing he should do is to install automatic controls for each room if there are none at present. Suitable thermometers should also be installed on all coils near their outlet ends. From his second paragraph, I take it he carries three different temperatures; if this is true, he should operate with three different suction pressures, if there is very much temperature difference. He should then adjust each automatic (if this type is used) to get the maximum refrigeration from each coil.

I have seen thermostatic expansion valves working to within two degrees of temperature corresponding to suction pressure, this gives a live frost on compressor manifold and still no slop-over into cylinder. By adjusting automatics to feed the maximum without slop-over, higher suction pressures can be had and consequently fewer compressors required. By carrying as high a suction pressure as possible, thereby getting ammonia temperature in coils as close as possible to the required room temperature, there is less drying out of the meat products stored therein.

By running too low suction pressures, this loss is very great at normal price levels; and at present prices it would warrant installation of more coil surface if suction pressures could be raised by doing so. In the plant I operate, we have rooms with sufficient coil surface and run with a 9 to 10 lb suction pressure on freezers in summer time and get room temperatures of zero to —4 degrees.

Two-stage compression should be used on the —20 to —30-degree rooms. A booster compressor should be used which discharges through an intercooler and into the suction pressure of machine running on cooler suction pressure. A 10-in. vacuum should be enough to get rooms to 30 below zero if there is near enough coil surface.

The intercooler can be used to serve two purposes; one to cool discharge of gas of booster before it enters the second stage compressor and the other to precool the liquid ammonia going to all the rooms. The intercooler is an accumulator with a float control to govern the ammonia level. The discharge gas from the booster passes through a special ammonia injector, which cools gas down before going to the second stage. On the inside of this intercooler is a coil through which all ammonia going to the rooms is precooled. The gas from the intercooler should discharge into suction of machines running on cooler rooms.

I don't know what the conditions are in this plant but 25 lb suction for 36 to 37 degrees in coolers seems a bit low if there is sufficient pipe for the load.

If C.O.S. wants to use heat exchangers on some part of the refrigeration system, I believe they could be used and get satisfactory results, although some arrangements would have to be made to precool discharge gas from booster compressor before it enters second stage compression. I have seen this done by discharging into the second-stage suction line, which contains enough wet gas coming from other rooms to cool booster discharge gas and still maintain a live frost on second stage suction manifold. This, of course, requires careful regulation of expansion valves. If heat exchangers are used, all liquid ammonia going to rooms should be cooled and this would not prevent him from getting too low a vapor pressure in freezer coils.

Any extra coils put into any of the rooms should not be used as superheat coils but should be used to full advantage. Setting an automatic or hand expansion valve with a thermometer on the outlet end of room coils can be gotten easy enough and trouble with slop-over should not be had after a little experience.

If heat exchangers are used, the expansion valves should be set to permit enough wet gas to come through to maintain a live frost on suction manifold of compressors. All the suction lines should be insulated from the rooms up to suction stop valve of compressor, if they run through unrefrigerated space.

If the compressors are the type with drilled connecting rods and wrist pins, the pins or brushings may be worn, thereby, letting an excess of oil above oil rings to be forced past compression rings. Worn ring grooves, cylinders out of round, or too much oil pressure in crankcase, will cause oil pumping, which will be more noticeable while operating on a vacuum.

I suggest that C.O.S. place suitable thermometers in suction inlet and discharge outlet of his compressors. The thermometer on suction inlet will tell him the amount of superheat in suction gas; from this, by referring to tables, he can tell if his discharge temperature is too high. Leaking piston rings or leaking valves in the compressor will result in abnormally high discharge temperature and a falling off of compressor capacity.

Since the high-pressure oil trap cannot collect all the oil discharged by the compressor, it follows that some of the oil eventually reaches the evaporators. This oil that collects in the coils reduces their capacity and efficiency by reason of its insulating effect. All coils should be provided with oil drains so all oil can be withdrawn without difficulty. The oil does not wear out or lose its lubricating properties in service, and if properly filtered, may be used indefinitely.

Ft. Thomas, Ky. WALTER H. HARVEY

Answer No. 341

How Draw Performance Chart for Non-Automatic Extraction Turbine?

Must Analyze Conditions for Several Uncontrolled Extraction Pressures

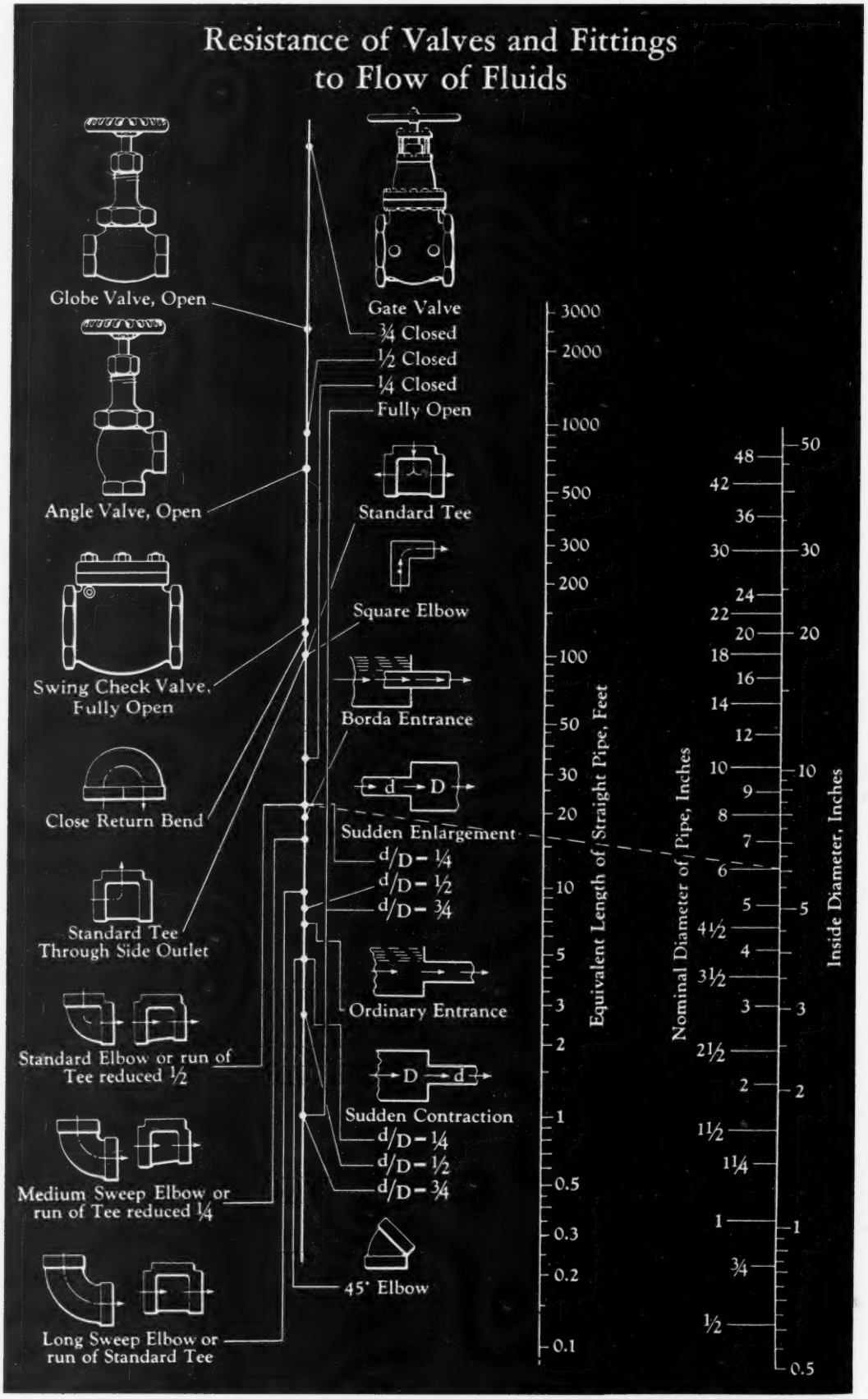
C. N. M. BRINGS UP an interesting problem in estimating the performance of non-automatic extraction type steam turbines. It is an oddity that the more simple the type of extraction the more complex becomes the method of estimating the performance. The reason for this, as C. N. M. points out, is that the pressure at the extraction opening remains constant on the automatic extraction type turbine, whereas it varies over a wide range with the uncontrolled type of extraction.

C. N. M. points out, too, that the parallel lines of the automatic extraction turbine performance chart become lines no longer parallel when the extraction changes from automatic to uncontrolled. It is possible to estimate the performance of these uncontrolled extraction turbines using a modification of the methods I have previously published in POWER PLANT ENGINEERING, (January, February, March, April, 1945, issues), but the process is neither simple nor foolproof.

Briefly, it is necessary to estimate what the pressure is under several different conditions and then determine the performance of each point as if it were an automatic extraction condition. This process must then be repeated for a number of points and then lines drawn through the field of points.

These lines will have the general shape of an automatic extraction chart except that they will fan out at the higher loads.

Lynn, Mass. L. E. NEWMAN



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A Working Philosophy of Human Relations

(*Continued from page 71*)

facts, and which idealistically attempts their solutions.

Basic to this philosophy, there are four assumptions—two of them negative in import, and two positive.

First assumption: **Human labor is not a commodity bought and sold.** A great many of our economic dislocations are the direct result of the application of the theory that men's labor was a matter of the market. The commodity theory of labor implies that man is an extension of the machine, a cog in a wheel, a bit of raw material to be refined. Just as industry and business have been forced to accept health laws, age laws protecting child labor, laws limiting the number of hours in which an individual could work, so also has the time come for management to recognize the spiritual law that man is not a commodity, but a growing, striving, wanting human being, with needs, aspirations and attitudes which are expressed in an infinity of ways and realized under an almost infinite variety of conditions. Failure to recognize the dynamic aspects of human personality, made a commodity theory of labor possible. Continued failure to develop a new theory of human relations will bring disaster in its wake.

Second assumption: **Human beings are motivated by more than money.** It is a great mistake to believe that the majority of labor unrest has its source in purely economic concern. All sorts of conflicts and tensions have been rationalized in terms of money, because money was much easier to talk about than mind. The fact is, however, that practically every major industrial conflict in our time has had its roots, not in the need for money as such, but in the need of a human spirit for a life conducive to the growth of that spirit. It is an interesting commentary, that management which has had enlightened personnel practices through the years and has recognized the subtleties of human needs, has had practically no labor trouble in the midst of an almost universal labor conflict. I have been a labor consultant for nearly 25 years, and in those companies where management was willing to recognize the truth of these first two principles and to give that truth proper instrumentation in business management, practices, there have been no strikes, lock-outs or work-stoppages.

Third assumption: The distinctly human drives that must be recognized by anyone who seeks to control human behavior are those which have to do with his egotic social and rational orientation to men and to life. **If a man possesses a job, rather than having the job possess him, he has a sense of well-being.** This is why job rights are so important; this is why seniority looms so large in the minds of organized labor; this is why many men endure the limitations of a closed shop principle—it gives them a sense of possession. When management can give men a sense of possession, apart from these external labor mechanisms, workers will invariably choose them to the former. When a company can give the workers a feeling that they are shared partners in a common enterprise, they have a sense of possession that nothing else can equal. This makes for industrial peace, for employees who stay on the job—for high production.

Fourth assumption: **Human behavior is predictable and controllable.** Too many people assume that although cause and effect rule throughout the rest of the human scheme, there is a large element of contingency in human nature. I do not believe that this is true. While there is much that still needs to be known about the causal factors in human behavior, everything we have so far found out points to the fact that there is a psychic and spiritual causation just as real, just as enduring and just as predictable as the law of gravity, or the law of thermo-dynamics. The trouble with us is that we do not use what we know to be true about human nature. Management neglects to recognize that a man is the sum total of the past decisions that he has made. Know the man and his background, and you can predict with a high degree of accuracy what his behavior will be like.

Build up the worker's ego by giving him a sense of possession, and he will take satisfaction from his work and will stick to the job. Thwart a man's striving for self-realization and he will become a Bolshevik, a malcontent, or a wanderer. Give a man security in his job, and he will produce right behavior. He will not have paranoid reactions of suspicion; he will not have occupational restlessness, and he will not be belligerent. If he has a feeling of insecurity, he will be all of these things, and more. Supply the worker with a real meaning for his life in his job, and he will not be primarily concerned with why the boss makes fifteen times more than he does, nor will he be victimized by the propagandists who seek to charm into violence by all sorts of illusory promises.

The other day, I read two statements made in confidential conference; one by an industrial consultant to a group of manufacturers—the other by a national labor leader to a group of his associates. Both were on the subject of how to deal with the collective bargaining problem. The industrial consultant man said, in effect: "Offer nothing. Make no statements. Offer no compromises, because if management takes the initiative in doing this, organized labor will immediately think that the sky is the limit, and they can ask for anything." It is interesting to me, on this individual, that most of the companies for whom he negotiates have strikes, work stoppages, long, involved collective bargaining, with pyramiding ill-will and hostility and aggression on the part of those economic representatives of the companies with whom they are negotiating. In more than six years of observation of this man's work, I have not known him to avoid a single strike, or to produce a contract which was very much better than the original demands of the union.

The labor leader, in speaking to his associates said, "Remember, the s.o.b's with whom you are going to deal are out to give as little as possible, so ask for everything. Never make any concession willingly, or at the time it is suggested. Fight for 100 per cent of what you originally asked for, and take advantage of every concession you make to get something else that you didn't ask for originally." Said he: "Remember this—you are dealing with men who think they are smarter than you are. Let 'em believe it, and then take advantage of how wrong they are."

This labor leader has sat in with me on more than one collective bargaining situation. When I knew what he thought about me and about management, I was in a very definite position of advantage. You can hardly imagine how difficult it is for a labor leader to deal with an individual who starts off by being completely honest, and who seeks sincerely to understand the needs, and aspirations of the men who are working for him.

These two philosophies of collective bargaining are bound to fail. They continue to be all too common in all collective bargaining conferences. Neither of these men really understands human nature. In the last analysis, they both fail, even when it appears that they succeed.

If we are to recover our economic strength in this country, it will be because management and labor, working together, produce vastly more in the way of manufacturing wealth than has ever been produced before. Unless we can increase the economic weight in the body politic by increasing the wealth of our land with relation to the debt which we are asked to carry, there can be no good life for us in the future at all. We have the machines, we have the mechanical power, we have the scientific and technological knowledge. What we need, above all else, is a working philosophy of human relations which will enable management and labor to satisfy each other's human needs. When this is accomplished, wages will become secondary in every collective bargaining conference.

Control of Radiant Heating Systems

By **J.A. CUTLER** President. Johnson Service Co.

FROM ALL EVIDENCE, it appears that the greatest single consideration in the control of radiant heating is the inherent thermal inertia of the system. It is obvious that a massive concrete slab, in which hot water pipes are imbedded, is not going to start emitting heat the minute hot water is supplied to the coils, nor is it going to stop emitting heat as soon as the water is shut off, or its temperature lowered. This thermal inertia is considerable, even in the case of ceiling or wall coils which may be covered only by a layer of plaster.

A room thermostat, as the primary means of control, generally will cause considerable cycling of the space temperature, whether it controls the quantity or temperature of the water supplied to the panel. On a rising space temperature, the thermostat reduces the heat input to the coils. However, the radiant surface continues to emit an excessive amount of heat for some time, during which the space temperature rises above the setting of the thermostat. This causes the thermostat to reduce further the heat input to the coils.

Eventually, the space temperature will cool down to the point where the thermostat again increases the heat input to the coils. Because the radiant surface previously has been cooled too much, its heat output will not meet the requirements of the space for some time, and the space temperature continues to drop. This results in a further heat input to the coils, the space temperature eventually begins to rise, and the cycle is repeated.

The above analysis applies, whether the thermostat in question responds to changes in air temperature, to radiant temperature, or to a combination of both, and shows that, by controlling from space conditions, the thermal inertia, or storage effect, of the radiant surface operates contrary to the requirements of satisfactory control results.

Because of the inherent thermal inertia in the radiant surface and the action described above, it is apparent that the need for a change in the temperature of the radiant surface must be measured before it is reflected by a change in space conditions, if these space conditions are to be held substantially constant. In most cases, the internal load is relatively constant, and the need for a change in surface temperature arises immediately upon a change in outdoor temperature. Therefore, for the primary control of a radiant heating system, an arrangement which varies the surface temperature according to changes in outdoor temperature, is necessary.

An analysis of the functioning of a radiant heating system under Johnson Duo-Stat control, an instrument that operates according to the relationship between outdoor and radiator temperatures, may serve to indicate further the advantages of this method. Assume that a drop in outdoor temperature occurs. This control immediately increases the heat input to the coils. However, due to the previously mentioned thermal inertia of the system, a certain amount of time elapses before this manifests itself by an increase in the temperature of the radiant surface. On the other hand, the drop in outdoor temperature does not immediately effect a change in the heating load on the system because of the time required to transmit this change through the building structure. Therefore, with this method of control, the thermal inertia of the radiant surface not only ceases to be a hindrance to good results, but definitely improves results because it is not desirable to change the heat output of the surface until the change in outdoor temperature becomes effective indoors. The ideal situation would be one in which the thermal inertia of the surface is equal to the thermal inertia of the building structure. Regardless of how seldom this ideal situation may occur, it is a fact that the thermal inertia of the surface is in the right direction with this method of control and is no longer a hindrance as it is when controlling from the space conditions.

Primary Controls for Radiant Heating

Below are outlined the recommended methods of primary control for radiant heating, keeping in mind that installations vary considerably in many details. The descriptions, therefore, will be general rather than specific.

1. An example of a simple application of a Duo-Stat to radiant heating is the operation of a valve in the steam supply to a hot water converter. This, of course, can apply only where the converter serves one zone.

2. When a radiant surface is heated from a cold condition, i.e., when the system is first operated, or after a prolonged shutdown, the coils and the material immediately surrounding the coils become warm much sooner than the rest of the radiant surface. This causes a differential expansion which, in time, may injure the material which comprises the surface. Some engineers, therefore, have insisted on gradually increasing the maximum water temperature, over a period of several days. To accomplish this, an immersion thermostat should be installed in series with the control described in "1," above, with its bulb in the converter discharge. If both are reverse acting, operating a normally closed valve, the immersion thermostat acts as high limit and can be adjusted as desired. If it is undesirable to use a normally closed valve, the same results may be accomplished with direct acting controllers, allowing the immersion thermostat to function through a 3-way air valve.

Either Method 1 or 2 may be used also in connection with the control of an automatic hot water boiler, instead of a converter. The instrument would be used to directly control a stoker, oil burner, or gas burner.

3. A slightly more elaborate arrangement is to control a valve in the steam supply to a converter by means of an immersion thermostat only, set for a temperature equal to the highest requirement. The instrument, then, operates a 3-way valve to control the water temperature to the zone. This arrangement is applicable where the converter serves any number of zones. The immersion thermostat still can serve as a means of gradually bringing the radiant surface up to temperature, as outlined in Method 2. The advantage is that the use of mixing valves as the final control insures less variation in the zone water temperature than occurs when the control is arranged as described for Method 1.

4. Method 3 makes use of an immersion thermostat to control the hot water temperature supplied to the zone mixing valves. This temperature is the highest which will be needed under severe weather conditions. Under mild weather conditions, the controls are required to mix a small amount of very hot water with a larger quantity of cool return water, to produce the required zone water temperature. A more uniform water temperature would result if the hot water from the converter could be always 15 or 20 F above the required zone water temperature. This suggests the use of another Duo-Stat in place of the immersion thermostat in the hot water line from the converter. This instrument would have its outdoor bulb on the coldest exposure and

Thermal inertia of system presents special problem . . . Room thermostat apt to cause temperature hunting . . . Radiant surface temperature should vary in accordance with outdoor temperature . . . Function of such a system of control analyzed . . . Several methods of primary control are recommended . . . Space temperature control effected by room thermostats supplementing primary controls . . . Ventilating system may carry part of heating load

a ratio equal to the highest ratio used on any of the zones.

5. In any of the primary control methods suggested, it might be desirable to arrange the controls so that the zone circulating pump is stopped whenever there is no longer a demand for heat. Thus, a pressure-electric switch would be installed so that the branch pressure from the zone control would stop the pump after it has closed the valve to hot water.

Space Controls for Radiant Heating

In order to obtain closer control of the space temperature than is possible with primary control alone, room thermostats should be used, to limit or modify the action of the primary controls.

1. As a limiting device, a room thermostat is installed in the zone, connected in series with the primary control, and if both the Duo-Stat and the room thermostat are reverse acting, the room thermostat functions as a high limit, cutting off the supply of heat to the coils whenever the space temperature exceeds its setting.

2. As a modifying device, a room thermostat, in the zone, is used as a pilot to readjust the primary control. Thus, with primary control the Duo-Stat is of the sub-master type, and the room thermostat serves to modify the setting of the instrument, in accordance with changes in room temperature.

3. Further refinement in space control can be accomplished by eliminating the zone thermostats mentioned in Method 2 and installing thermostats in each room. These thermostats would operate throttling or 3-way valves in the supply lines to the panels in their respective rooms.

Room Thermostats and Primary Control

The purpose of the above outline of various control arrangements is to show that the control of radiant heating systems differs little from conventional methods used on installations involving direct radiators or convectors. Room thermostats can and should be used wherever the most accurate results are desired, provided that they are used in conjunction with a suitable primary control system based on varying the water temperature in accordance with the outdoor temperature.

There has been some agitation from a number of quarters for a space thermostat which will respond to the mean radiant temperature in a space, or to a combination of mean radiant temperature and air temperature.

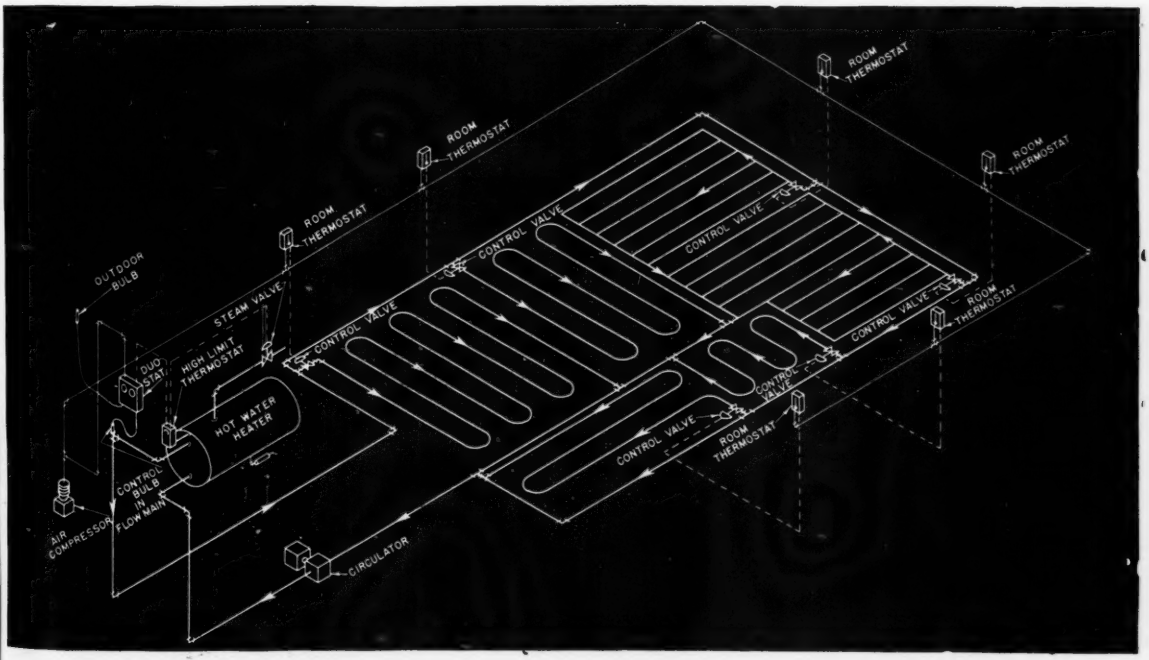
Considering the theory of radiant heating, the two variables affecting the heat loss from the human body, insofar as this discussion is concerned, are radiation and convection. Where a radiant heating system is employed, less body heat is lost by radiation than with a conventional heating system, because of the higher mean radiant temperature of the surrounding surfaces. However, more heat is lost by convection, because of the lower air temperatures. In any event, the body loses heat by both means. Since there is a definite relationship between the mean radiant temperatures and the air temperature in a given space (where forced ventilation is not used), an ordinary room thermostat can be used if a limiting or modifying device is desired.

Forced Ventilation May Be Added

Most advocates of radiant heating point out that lower room temperatures are permissible than are possible with conventional heating systems, without going to the trouble of explaining how these lower room temperatures are produced. The fact is, with a normally "tight" building, heated by radiant surfaces, that the air temperature will tend to rise until, finally, it is practically at the same value that would be maintained in convection heating systems.

In order to maintain room air temperatures that are much below the mean radiant temperature of the surrounding surfaces, some form of forced ventilation is required. Control of the forced ventilation system

Control diagram for radiant heating system using Duo-Stat and high limit thermostat controlling diaphragm valve in steam supply to hot water heater with room thermostats to control diaphragm valves in water supply to individual room coils



need be no different than when used with direct radiation; that is, a fan discharge thermostat regulates the temperature of the air delivered to the space at a level equal to, or slightly below, the desired space temperature. The use of forced ventilation should not alter the basic control system for the radiant heating plant.

The ventilation system is sometimes designed to carry part of the heating load, just as is done with direct radiation. This arrangement is more often used to supplement radiant heating surfaces located in floors. Control of the temperature of the air delivered would be by one of the following methods:

1. A sub-master fan discharge thermostat reset by an outdoor master thermostat. If supplementary heating is needed only during periods of lowest outdoor temperatures, the master thermostat would be adjusted to operate only over this range. Assume a design temperature of minus 10 F, and a radiant system that can carry the heating load unaided, at outdoor temperatures of plus 20 F and higher. Then the master thermostat would be set to produce full resetting effect from plus 20 F to minus 10 F. At all other times the fan discharge thermostat would control at its base setting.

2. The fan discharge controlled as above, with a room thermostat acting as the master to the fan discharge thermostat.

3. The fan discharge controlled by a room thermostat directly, in conjunction with a low limit, fan discharge thermostat.

In either of the last two methods, the fan system supplements the radiant heating system whenever the space temperature drops below the room thermostat setting.

Location of Control Bulb

While some installations have been made with the instrument control bulb imbedded in the radiant surface, with good results, it is believed that fully as satisfactory results are obtained when the control bulb measures the temperature of the supply water. This should also make a more simple installation. The control bulb may be strapped to the outside of, or inserted into, the supply pipe. For steamheated surfaces, the control bulb should be inserted in the panel structure. When the bulb is thus inserted, the usual practice is to bury a straight section of pipe in the panel, with the open end left accessible, so that the bulb may be slipped into it to the proper distance. Some provision should be made to remove the bulb without placing an undue strain on the capillary tubing, and this can be accomplished by attaching a piece of wire to the bulb to permit it to be withdrawn.

Although most of the radiant heating installations on which data are available make use of proportional operating controllers, the very nature of this type of heating system would lead us to expect fair results from two-position operation, if other considerations indicate that such control is desirable. The large storage capacity of the surface tends to even out its rate of heat emission, in spite of the fact that the heat may be supplied in cycles. Of course, the shorter and more frequent the cycles, the more uniform the output of the surface, and therefore, better results should be expected with two-position operation if the control bulb measures the supply water temperature than if it measures the temperature of the radiant surface. On the other hand, two-position operation should not be used if the control bulb measures the temperature of the water, and the controller operates a mixing valve, because extremely short cycles will result. In this case, the control bulb should be located in the surface, or in the return line from the surface. Generally speaking, there will be very few cases where two-position operation is necessary, and it is recommended that proportional operation be employed whenever possible.

G.E. BUILDING 100,000 KW TURBINE GENERATOR

ANNOUNCEMENT OF a 100,000 kw maximum rating turbine generator for operation at inlet conditions of 1250 psi and 1000 F at 3600 rpm has been made by the Turbine Division of the General Electric Co. The new unit, now under construction at the Schenectady Works of G. E. and scheduled for delivery in the early part of 1947, is the largest of its type in the world, and will be used at the Essex Station of the Public Service Electric and Gas Company of New Jersey.

Dimensions of the tandem-compound double-flow machine, which will operate at the highest steam temperature so far undertaken for a unit of this capacity, are 77 ft long, 17 ft wide, and 11 ft high. There are 19 high-pressure stages and five stages in the double-flow low-pressure side. The last-stage wheel carries a new 23-in. long bucket of variable-angle double-warped airfoil section. Maximum tip speed of the buckets is 1390 fps. Special provisions are made in the low-pressure turbine for greater removal of moisture and therefore further reduction of moisture cutting on the buckets.

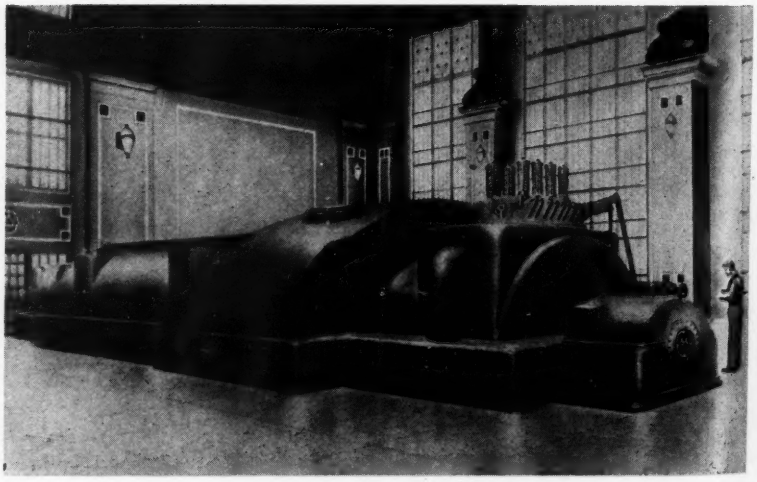
The turbine is condensing, and exhausts at 1½ in. Hg. Eight extraction points are provided. There is no reheat.

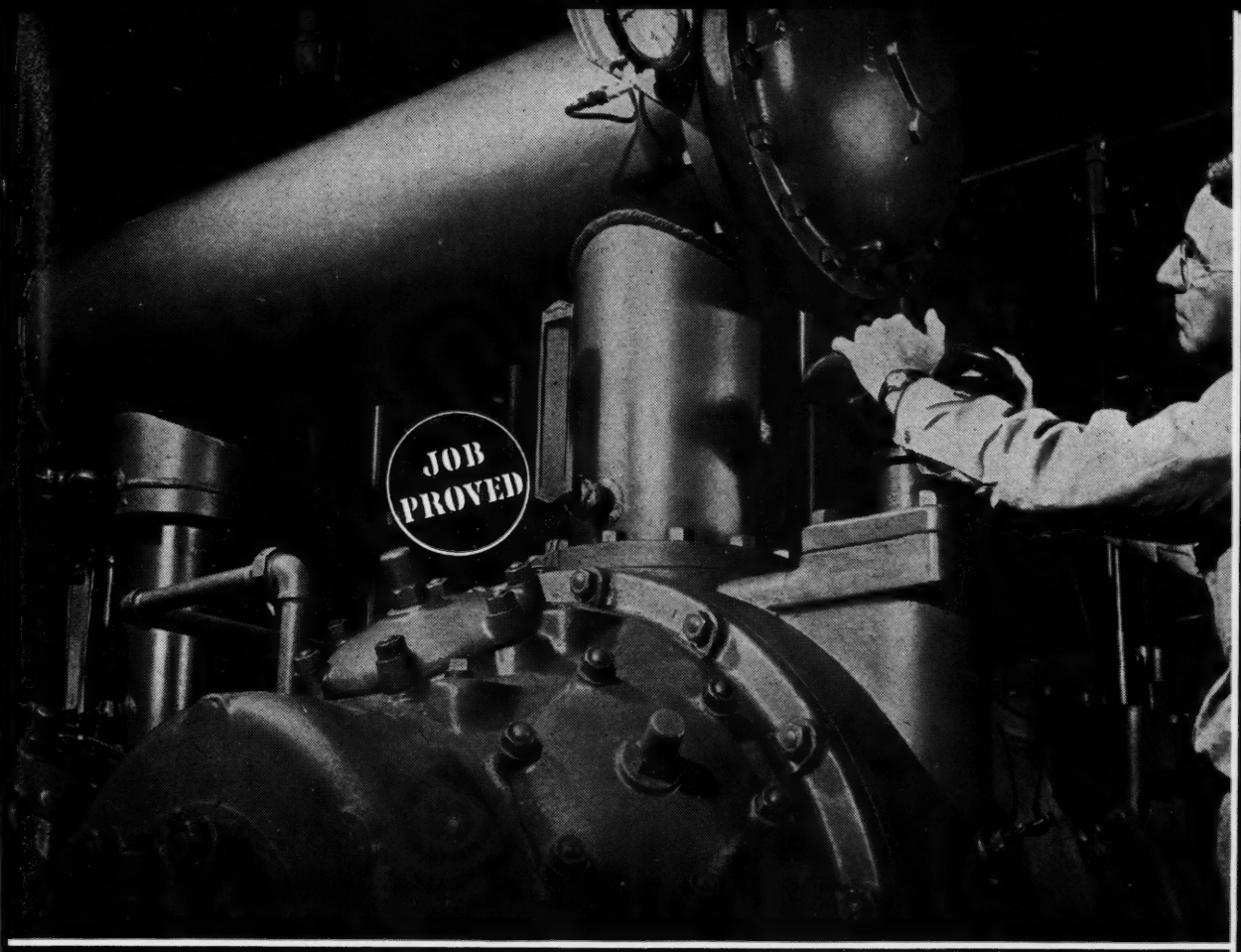
This turbine will also have a newly developed hydraulic and oiling system with a centrifugal pump mounted on the turbine shaft. Oil is supplied to the inlet of the pump by an oil-turbine driven booster pump in the oil tank in the basement.

The exterior appearance of the turbine will be characterized by long, low lines and complete covering of all moving elements. This modern styling assures maximum safety for operating personnel but has not been carried out at a sacrifice to ease of operation or accessibility. Another feature is that the instruments and controls have been grouped at the turbine end of the unit for convenience of operators.

The generator, largest 3600 rpm machine ever constructed, is rated 95,000 kw, 0.85 pf, and 0.85 short-circuit ratio at 15 psig hydrogen pressure. The set is also equipped with a 7500 kw direct-connected house alternator.

Hydrogen cooling of the generator is accomplished by means of four vertical cooler selections mounted in the corners of the generator. The stator core of the generator is of modern spring-mounted construction to minimize double-frequency vibrations from being transmitted to the frame or foundation.





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ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Will an Atomic Power Plant Pay?

By

C. F. WAGNER and **J. A. HUTCHESON**

Manager, Central Station Section — Assistant Director, Research Laboratories

Westinghouse Electric Corp., East Pittsburgh, Pa.

IS NUCLEAR ENERGY commercially feasible? If so, how will it affect the present forms of fuel-fired power plants? Too many facts are still missing to allow complete answers to this question. However, it is a help to one's thinking to assemble the knowns, and these can be supplemented by estimates of cost that can readily be made by any power engineer armed with a slide rule and a few assumptions. The gist of the conclusions arrived at by such an interim study is that nuclear-energy is quite likely to become commercial, that the cost will not be excessive but neither is it likely to revolutionize power costs, and-very important that numerous large technical difficulties must be resolved—probably by years of development—before a commercial nuclear-energy power plant can be established.

Government Restrictions

At the moment, private experimentation with fissionable materials is not generally allowed. That the government will continue to exercise strict control over ownership and experimentation with fissionable material goes without saying. What sort of controls over the production and use of nuclear materials will be established we still do not know. On August 1, the McMahon Bill, battered in the House but restored to almost its former self in the Senate-House conference, was signed by President Truman and became the law of the land. Whether this law will be changed or amended time alone will tell. Probably fissionable materials will be made available under strict supervision for commercial experiment and possibly for commercial use. At present, however, civilian experimentation with uranium is strictly limited.

It is relatively easy for anyone familiar with the electric power industry to make an estimate of cost of electricity produced from uranium disintegration. It involves, of course, numerous assumptions that may or may not prove to be justified but which seem to have considerable foundation. On this basis, nuclear-produced power seems to be not so cheap as to revolutionize the power picture but neither is it so high as to preclude its consideration as a competitor to ordinary fuel.

To establish some general boundaries of costs, let us estimate the comparative economics of two 100,000-kw power plants, one using coal or oil and the other nuclear-energy obtained from a pile including pure but natural uranium. Present indications are that the first useful plants will be large, possibly of the order of 100,000 to 200,000 kilowatts. Because of the shielding required to protect personnel from the incidental radiations, it does not now appear feasible to consider smaller size plants.

Our hypothetical power plant will use as its fuel purified natural uranium. In this unenriched state, uranium contains 0.7 per cent by weight of the active U235 isotope. The total available energy of the "pile" is then 81,500 kwhr per pound of the uranium metal. There will be the usual radiation and exhaust losses so that an overall thermal efficiency of 25 per cent can be assumed in converting the available thermal energy into electrical energy. Thus 20,400 kwhr of electrical energy are obtained from each pound of pure, natural uranium. This ignores the heat obtained in the operation of a uranium pile as the result of formation and eventual fission of plutonium from U238. Little data on this is available, but in a commercial plant credit would of course be taken for this heat.

Table of comparative energy costs 100,000-KW power stations using pure, unenriched uranium and coal (50% load factor)

	Investment in Uranium-Powered Plant—Dollars per Kw			
	$120		$180	
Uranium Cost Dollars per pound	Mils per Kwhr	Equivalent Coal $ per ton	Mils per Kwhr	Equivalent Coal $ per ton
0	4.1	1.8	6.2	5.4
5	4.4	2.3	6.4	5.8
20	5.1	3.6	7.1	7.2
50	6.6	6.2	8.6	9.8

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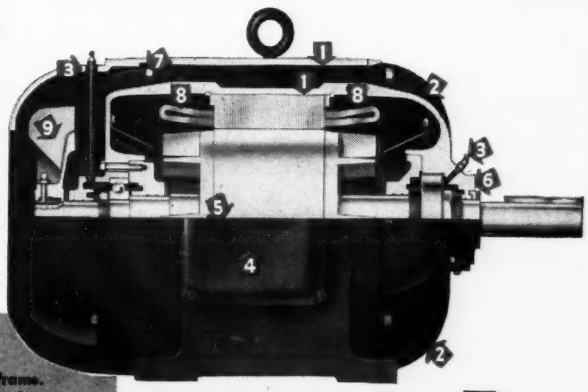

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GENERAL ELECTRIC

WILL IT PAY TO SPECULATE ABOUT ATOMIC POWER PLANTS?

(Editorial Comment)

YES, IT WILL, in our opinion, provided we remember it is not our No. 1 problem. The No. 1 problem is to prevent the atomic warfare that would stop all our speculations. But the more we can concentrate on showing how the development of atomic energy for peaceful purposes far outweighs its use in war, the better we can dispel the fears of mankind that it is primarily another weapon.

In thinking about atomic power plants, remember—

1. There is no atomic bomb "secret," except our manufacturing skill and productive power.

2. Present ratio of uranium supply to coal supply is small. The sunlight equivalent of U-235 in known deposits before the war is 3 min; the sunlight equivalent of known coal resources, 15 days. But exploration for uranium may change the story.

3. From wind, water, tides we could secure all the power we need if we had no coal, oil or gas, but at a tremendous cost. Even hydro power sometimes has a hard time to beat our best steam plant costs.

4. Cost of fuel is a small part—¼ to ⅓—of the total cost of generating power—often about 1/10 of the cost delivered to the user. Uranium would only replace the fuel, to generate electricity.

5. Uranium as a fuel would have small weight, transport costs might be lower. Shielding would be a problem.

6. Uranium fuel does not require oxygen, could be used underground, discharges no flue gas to atmosphere, (the "ash" would still have to be removed).

7. Countries with no fuel or water resources might be able to sustain a power economy based on atomic power.

8. The by-products of atomic fission now being released for use in tracer chemistry may be of more social benefit than the power.

9. With our present knowledge, the problems of corrosion and safety in atomic energy conversion do not seem insuperable.

10. Stability of operation and ease of control are characteristics of the present atomic energy plants.

11. Unpurified natural uranium before the war cost $1.80 a pound, or about $250 a pound for unseparated U-235. Further development will decrease costs.

12. Synthesis of light elements, with release of atomic energy, as in the sun, is not possible in the light of our present knowledge.

13. An experimental full-sized atomic power plant is now being built by the government at Oak Ridge, Tenn. Here we shall get many of the answers to the problems indicated above.

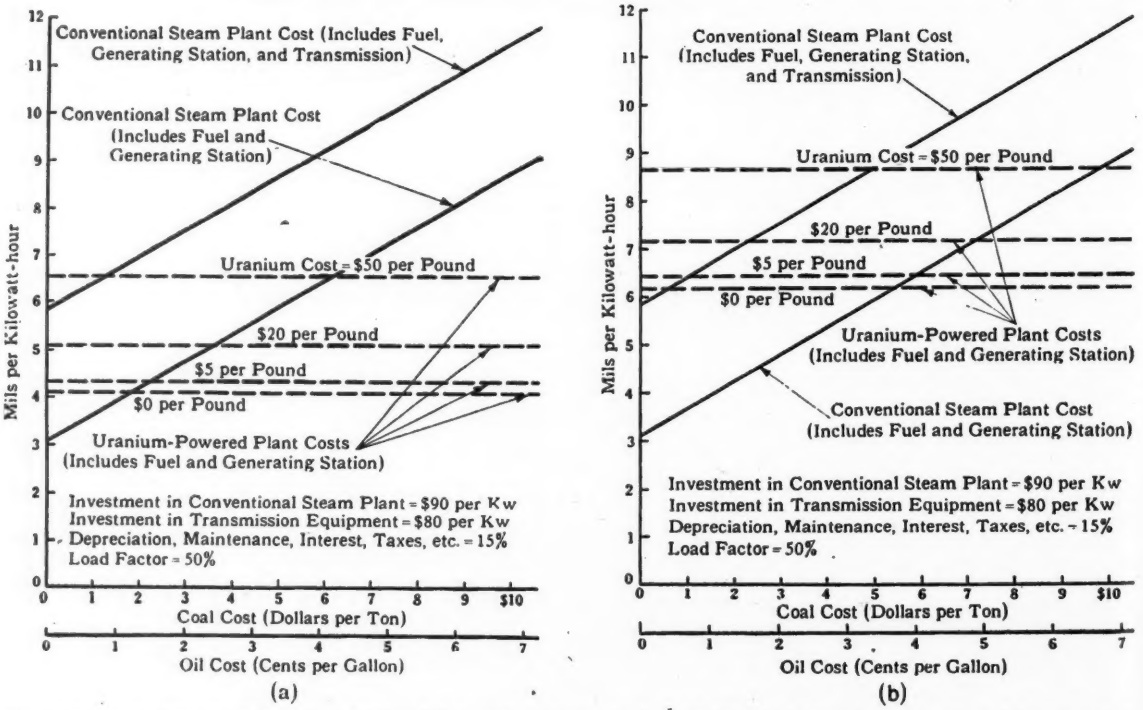
The present article, much of which is speculation, is based on facts such as the above, all of which have been published. Power engineers are eager to co-operate in advancing the development, for they will necessarily be an integral part of it.

Yes, this sort of speculation will pay, for it will help us evaluate the results obtained from the Oak Ridge experimental atomic power plant, which may be in operation sooner than many people believe possible.—C.R.E.

The cost of pure but enriched uranium has been quoted in the literature as being about $20 a pound. With mass-production methods the actual cost may be considerably less than this figure. However, the first cost of uranium may not be its effective cost. When a U235 atom is disintegrated by bombardment of a neutron, other products are formed, in addition to the release of energy. These are elements of roughly half the atomic weight of uranium. Barium, with atomic weight of 137, and krypton, atomic weight of 83, are representative fission products. These products tend to poison the pile, i.e., to neutralize the process just as ash accumulating around a lump of burning coke retards combustion. The full energy of the U235 cannot be obtained from the pile without the removal, from time to time, of this nuclear-reaction "ash" so that the process can continue.

This periodic refining or repurifying of the uranium is a chemical process. It entails additional expense, but how much is as yet unknown. In view of the foregoing considerations, the cost of uranium in this study has been varied over a range of from 0 to $50 per pound, each pound of which makes 81,500 kwhrs of energy available by fission.

The exact manner in which the energy in a uranium pile will be used in the generation of electrical energy is still subject to further investigation. However, we shall assume a conventional steam or gas turbine and that steam, or some other gas, will be passed through the pile. In other words the pile would replace the boiler, stoker, draft machin-


Conventional Steam Plant Cost (Includes Fuel, Generating Station, and Transmission)
Conventional Steam Plant Cost (Includes Fuel and Generating Station)
Uranium Cost = $50 per Pound
$20 per Pound
$5 per Pound
$0 per Pound
Uranium-Powered Plant Costs (Includes Fuel and Generating Station)
Investment in Conventional Steam Plant = $90 per Kw
Investment in Transmission Equipment = $80 per Kw
Depreciation, Maintenance, Interest, Taxes, etc. = 15%
Load Factor = 50%
Mils per Kilowatt-hour
Coal Cost (Dollars per Ton)
Oil Cost (Cents per Gallon)
(a)
Conventional Steam Plant Cost (Includes Fuel, Generating Station, and Transmission)
Uranium Cost = $50 per Pound
$20 per Pound
$5 per Pound
$0 per Pound
Uranium-Powered Plant Costs (Includes Fuel and Generating Station)
Conventional Steam Plant Cost (Includes Fuel and Generating Station)
Investment in Conventional Steam Plant = $90 per Kw
Investment in Transmission Equipment = $80 per Kw
Depreciation, Maintenance, Interest, Taxes, etc. = 15%
Load Factor = 50%
Mils per Kilowatt-hour
Coal Cost (Dollars per Ton)
Oil Cost (Cents per Gallon)
(b)

Charts showing relative cost of power developed by uranium versus coal or oil. Fig. (a) is based on an estimated investment of $120 per kw in the uranium-powered plant; Fig. (b) is based on $180 per kw.

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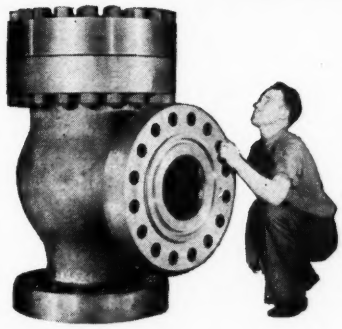

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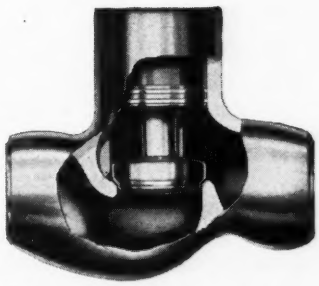

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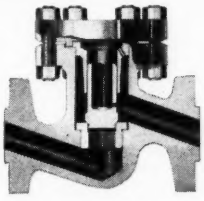
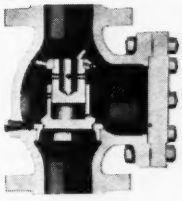
MEDIUM



Exclusive Edward disk guide lip aids tight seating and cuts wear on seat and disk through momentary throttling action.

Edward check valves may be disassembled without removing from the line. Covers are forged steel.



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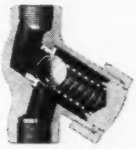
For viscous fluids or hydraulic service, Edward ball checks are ideal. Stainless steel ball is mated to seat.



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ery, fuel-storage and fuel-handing facilities, and present ash-removal equipment. Some of the energy-conserving devices like feed-water heaters, reheaters, etc., used in fuel-fired power plants to squeeze the last Btu out of the fuel might prove uneconomical with the uranium-pile plant. Also, the economic justification of a steam condenser would require study.

Investment

Inspection of investments reported on several conventional steam generating stations within range of 100,000 kw indicates that a total investment of $90 per kw of installed capacity represents a typical investment in a modern coal-burning steam station. A further apportionment of cost is made by estimating that boilers, turbines, and steam auxiliaries cost $30 per kw of installed capacity. This portion of the total cost is segregated because apparently only the "mechanical equipment" in a generating station will be radically changed from present design to accommodate atomic fuel. Electrical equipment, exterior building, and service equipment are not expected to undergo such sweeping changes that their costs will be materially altered.

To reduce fixed costs to a basis comparable with fuel costs, it is assumed that yearly depreciation, maintenance, taxes, interest and labor charges will amount, in total, to 15 per cent of the entire plant investment. In evaluating the fuel costs of a coal-burning plant, the heat content of coal is assumed to be 12,000 Btu per lb., and the efficiency of conversion of fuel to electrical output is assumed to be 25 per cent.

It is anticipated that an atomic-fuel generating plant will cost more than a conventional coal-burning plant. It further appears that the major increase in cost will develop in the mechanical equipment section, composed of boiler, prime mover and associated auxiliaries. Cost increase factors of both two and four are considered in this analysis. These factors are applied to the cost of mechanical equipment in a conventional steam plant, resulting in costs of $60 per kw and $120 per kw respectively for the heat utilization equipment peculiar to an atomic powered generating system. Translated into terms of total investment, these estimates permit $6,000,000 and $12,000,000 to be spent for the specialized equipment necessary in an atomic power plant. If to these totals are added those costs believed to be substantially constant ($6,000,000), figures of $12,000,000 and $18,000,000 result as total station investments.

To reduce the total investment estimate to a basis comparable with fuel costs, yearly costs aside from fuel were estimated to be 15 per cent of total investments; this results in yearly charges of $1,800,000 and $2,700,000. If the 100,000-kw station under consideration operates at 100 per cent load factor, these yearly costs reduce to 2.06 mils per kilowatt-hour and 3.08 mils per kilowatt-hour. If the station operates at only 50 per cent load factor, fixed charges will be 4.12 mils per kilowatt-hour and 6.16 mills per kilowatt-hour.

If the eventual design of atomic power plants should permit their being located near the electrical center of the load which they serve, a substantial decrease in cost of power transmission would result. While it seems unlikely that all power transmission costs could be eliminated in any practical case, such a condition is considered in this analysis in order to establish the range through which costs might be affected by reduction of investment in transmission lines. It is assumed that transmission costs in a typical power system is $80 per kw of installed capacity. This cost can be distributed at the rate of 2.74 mils per kilowatt-hour, if yearly charges are again evaluated at 15 per cent and system load factor is 50 per cent.

The figures resulting from the calculations based on these several assumptions are given in Fig. 1 for a load factor of 50 per cent. They show that with uranium at $20 per lb. and with uranium-plant investment of $120 per kw, the energy cost is 5.1 mills per kwhr, Fig. 1 (a). This corresponds to the energy cost of a station using coal costing $3.60 per ton or oil at 2.4 cents per gallon. The corresponding energy cost for $5 uranium is 4.4 mils per kwhr and for $50 uranium, 6.6 mils. Fig. 1 (b) similarly considers the case where the uranium plant investment is taken at four times that of the comparable elements of the conventional plant, i.e., $180 per kw.

The salient figures based on these assumptions are summarized in Table I. It must be emphasized that these comparisons hold only for the given assumptions, which for clarity are repeated in Fig. 1 (a) and (b). For other assumptions similar comparisons can be made. The results of this comparison should assist in orienting the economic position of atomic power.

Other factors than straight economics will probably dictate when and where uranium-pile power plants will materialize. Whereas the uranium pile simplifies the power plant in some regards, it brings with it a host of engineering problems of first order of magnitude.

Most of these problems center around the radioactivity of the products of the nuclear disintegration. These end products and everything exposed to them, such as the water or other heat-exchange medium, become powerfully radioactive. The radiations produced as the atoms return to a stable state are extremely hazardous to life. Consequently the pile itself and all parts of the system in contact with the heat-carrying medium, and this may include the turbine, must be carefully shielded to protect the personnel. This requires considerable masses of materials surrounding the equipment.

Much of the nuclear-energy apparatus will have to be operated remotely. As has been mentioned earlier, the uranium bearing material must be removed from time to time in order that it may be repurified. This requirement imposes many problems. Means must be provided to handles these intensely radioactive elements without endangering the well-being of the personnel. This implies remote handling and disposition of these elements. Similarly if any of the control devices should fail, they cannot be repaired because they too would be radioactive. Therefore it is likely that means will be provided which will permit remote handling and replacement of the control devices.

In short, while the brilliant, breathtaking achievement of tapping the storehouse of nuclear energy has been achieved, there remains a multitude of engineering problems that must be painstakingly solved before the new ability can be put to workaday use.

Size of Pile

For the energy-releasing reaction to be continuous or self-sustaining in a pile including uranium, the size of the pile must be above a certain critical large size. This size has not been definitely stated but is of the order of several tons or a block several feet on a side. If the pile were small—i.e., a lump in which the ratio of surface to volume is larger—the loss of the reaction-causing neutrons from the surface would be so great as to not allow the reaction to be self-sustaining.

Moreover "ash" accumulation means that the pile size must be considerably above a critical size otherwise these accumulating impurities would soon absorb so many neutrons as to stop the reaction. Therefore, a pile capable of reasonably constant energy release requires a large mass of fissionable material and also movable neutron absorbers, such as cadmium, as control devices. Then ash accumulation can be compensated by gradual withdrawal of the absorbers. This can be continued, holding the energy release substantially constant, until the control devices have been withdrawn, after which the reaction speed would decline and eventually

It is a human characteristic to interpret the new in terms of the old, and thereby so often misjudge the new. That may be what is happening with atomic power, just as the first automobile was conceived as a buggy driven by an engine.

Perhaps atom-fuel power will be of greatest use at places on the earth where there is now fuel famine.

Other quite different methods of tapping the atom storehouse may be found.

Certainly we cannot ignore atomic energy. It is of major importance to us as engineers, and even more important as citizens of the world.—Wagner & Hutcheson.

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cease altogether. For practical power purposes such operation would be unsatisfactory. It is this fact which requires the ability to reprocess and repurify the atomic fuel without necessitating shutdown of the pile.

Enrichment of the U235 isotope of the uranium would make possible correspondingly smaller energy-releasing piles. Increase in the proportion of U235 could be continued until, as in the atomic bomb, the critical size for self-sustaining reaction becomes relatively small. Although possible, this procedure rapidly increases the expense of any commercial form of energy generator. In the atomic bomb project three methods of isotype separation, i.e., U235 enrichment, were applied successfully. All were costly, although uranium isotope separation can unquestionably become more economical. There is always, of course, the possibility that some new and cheaper method of isotope separation may be developed. However, as matters stand now, U235 enrichment is costly—so much so as to make its use as a power-plant fuel unlikely.

The high cost of a pile of small size is, incidentally, one of two reasons why small power plants for ordinary purposes like vehicles are out of the question. The other is that the weight of the shielding required to protect passengers and operators from the intense radiations raises the bulk to unreasonable proportions for automobile, aircraft, and probably locomotive use. For submarines or battleships, on the other hand, where a saving in fuel storage, weight, and volume has great value and where necessity of refueling is a disadvantage, such a power plant may prove justified. Generally, a "teacup" size nuclear-energy power plant is, at present, pure fantasy.

INTERNATIONAL CONTROL OF ATOMIC ENERGY

This constitutes the second part of an analysis of the Report of the Secretary of State's Committee on Atomic Energy. Part I was presented in the June issue. This portion is confined largely to Under Secretary of State, Dean Acheson's interpretation of the Report before the American Society of Newspaper Editors in Washington on April 20. Dean Acheson was chairman of the Atomic Energy Committee. Here, in clear, simple language you will find the essentials of the report

IN THE PRECEDING ARTICLE in the June issue, there was presented a brief outline of the report of the Secretary of State's Committee on Atomic Energy. This report advocates the control of atomic energy by international control of uranium mining, the production of plutonium (the essential atomic element) and the manufacture of atomic explosives. Given these controls, the Committee believes no country could start atomic warfare without at least a year's advance warning.

In their deliberations concerning the control of atomic energy, the Board of Consultants appointed by the Committee, naturally asked themselves whether there might be other activities having to do with atomic energy which would not be "dangerous." They agreed that there were such activities and that these, indeed, were very important. There is the use of radio-active tracer materials. This is perhaps the most promising of all the uses of atomic energy. Used, for example, in research in regard to the human body, in regard to all vegetable and animal matter, you have a tremendous opportunity of tracing all the various reactions which occur in living organisms and in that way learning more about these reactions than could possibly be learned in any other way.

Now that is not a dangerous activity. It is not dangerous because the amounts of fissionable material used in any one of these research operations is so small that if you put together all that would be needed for research in one country, or even in several countries, you still would not have enough material to do any harm.

Then, the consultants said, there are other activities which are not dangerous, which in turn produce radioactive tracer materials or which are used for experimental and testing purposes in industry or in chemical, physical or biological research. Again, this activity is not dangerous because there would not be enough material in one or a dozen of them to do any harm.

There is still another activity full of promise for the future, and that is the production of power. Here you begin to approach the field of danger, because in the reactor that will make power you will need so much of the fissionable material that it might be dangerous. Even so, the consultants believe that by care in designing reactors a large measure of safety could be achieved. Moreover, the consultants studied this matter further, and concluded—that by denaturing the fissionable material an additional safeguard could be provided. In the development of power from the fission of denatured U-235 and plutonium in high power level reactors, the range of power production would lie between 100,000 and 1,000,000 kw.

If these fissionable materials are used in installations where there is no additional uranium or thorium, they will not produce further fissionable material. The operation of the reactors will use up all the material.

Denatured Fissionable Material Can Be Processed but It Is Difficult

Now, when this conclusion in the report first became known, it was taken up and distorted. People like to make things seem simpler than they often are. So they quickly jumped to a conclusion that we in our discussions referred to as the theory of the good and the bad fairy. The bad fairy set out to destroy the world, and the good fairy came and waved her wand, and the world was not destroyed; no harm was done. That is not a correct reflection of the facts. What the consultants say in their report is that these fissionable materials can be so processed or treated after they are produced that only by a major industrial effort can they be processed further so as to be used effectively in explosives. That doesn't mean that it can't be done. It means that it is a very difficult job to do.

What is the significance of this? Its sole significance is that it makes it safer than it otherwise would be to permit a rather broad use by nations or by individuals of fissionable materials in the production of power.

Now, with these conclusions before them, the consultants went back, set forth what they regarded as the essential facts and came out with their report. As the Secretary of State said in his foreward, it is not a statement of Government policy. It is purely a working paper for the consideration of those who have to determine Government policy. The proposal is that by agreement among all the nations of the world the raw materials of uranium and thorium shall be in the hands of an international organization created by treaty, with powers and functions very specifically spelled out in the treaty. Wherever uranium and thorium occur in useful quantities, they shall as a matter of treaty right be under the control of the international organization. The international organization shall have the sole right to work these materials and to produce them. It may do the work itself or it may have other agencies carry on operations for it. The important thing is that it shall have the right to determine how the exploitation is done, because it is only by having the managerial authority, the complete power of direction, that there can be any effective accounting and control, so these materials will not be per-

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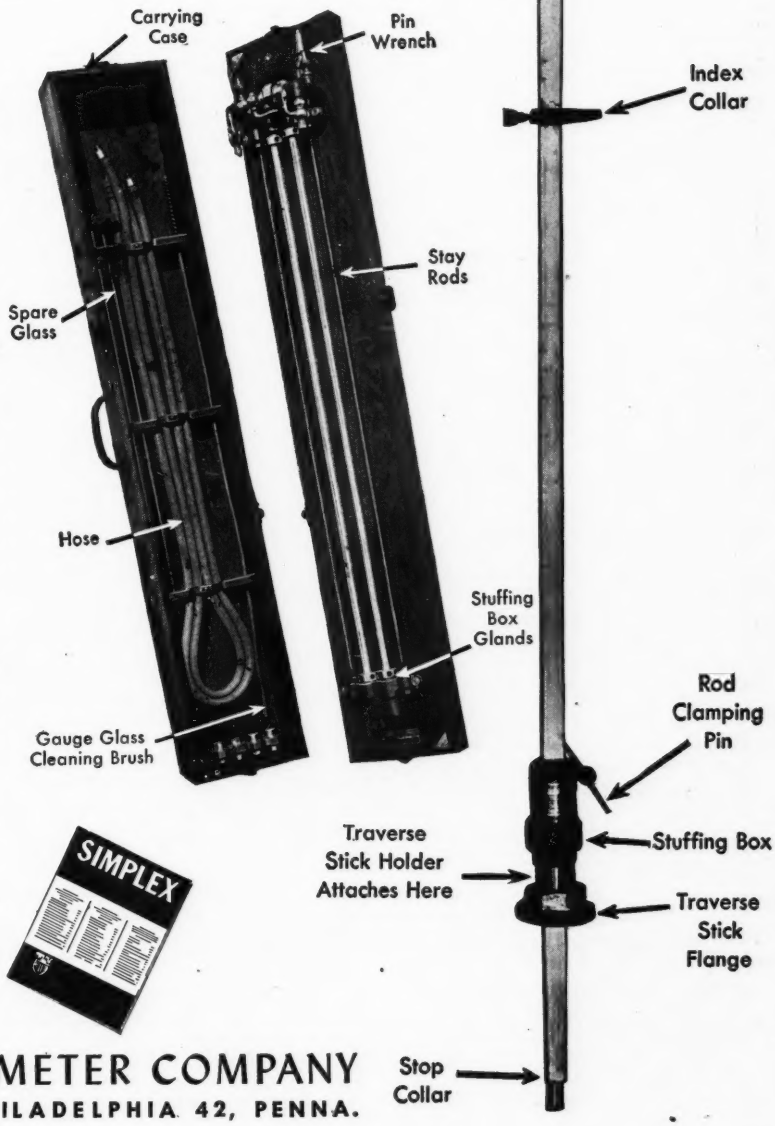

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We Don't Have to Look for a State of Mind

Now, you immediately begin to get international control more nearly within more practical bounds and limits. Under the arrangements contemplated by the consultants, anyone who is inspecting is not looking for a state of mind; he is looking for an activity. When he finds the prohibited activity, he knows that a treaty has been violated, and he knows that trouble is brewing, and he can say so. If some person or some nation is producing uranium and thorium, it doesn't make any difference what their state of mind may be. And if uranium and thorium are being produced, the fact can be readily ascertained, because the international organization in the ordinary course of its business is sending its prospectors into all countries of the world and discovering through geological exploration where the sources of uranium and thorium are. Should the inspectors see new holes in the ground opening up, they would inquire into the reasons. Without being a group of prohibition enforcement officers prying into everybody's business, they can in the conduct of their own business find out what is going on.

Then the report proceeds to say that the second dangerous step—the production of fissionable material—must also be within the control of the international organization. This is a highly dangerous step. The international organization must be the only organization which produces fissionable material. Again, if the inspectors or the personnel of the international organization discover or hear about or have instruments which record the existence in any part of the world of a building, a factory or a plant producing fissionable materials, those are illegal activities, and the world is put on notice.

The suggestion is made in the report that the treaty spell out how fissionable materials are to be produced. For the most part, they can be produced in such form that the final product cannot, without additional effort, be used to make explosives. The plants which produce these materials can produce, also, a great amount of power. It is estimated that half of the power that would be produced through atomic energy could be produced in these primary plants which produce fissionable materials. It would be produced in the plants of the international organization but would be turned over to the nation in which it was produced, for disposition according to that nation's policies.

Plants to Be Distributed Throughout the World

It is also stated in the report that it is desirable that these plants be so distributed about the world that there can be no thought in the mind of any party to the treaty that the strength which would come from having these plants is concentrated in one country. They should be so scattered about that there would be no temptation on the part of anybody to gain a monopoly within the borders of a single nation.

There is, of course, a possibility of danger in this situation. Everyone understands that a nation that has decided to violate the treaty might send its soldiers in and take over a plant operating under the international organization. The organization would be quite powerless to prevent that, because no one can resist the force of a great power within its own borders. The plan is not designed to prevent that. It is so set up that, if such a development should take place, it would constitute a clear, out-and-out, notorious violation of the treaty, and all the world would be put on notice that the nation involved in embarking on an aggressive policy that must inevidently lead to trouble. The world is also put on notice in sufficent time so that the other nations can make their dispositions and be ready for trouble.

The consultants estimate that any nation taking such action with one of these plants would not be in a position, within one year and possibly not within two or three years to use what it had captured to make actually dangerous amounts of explosive material. The reason is that the nature of plants would be such that, in order to produce explosive material, there would have to be major additional production and additional construction, and that would take a long enough time so that the world could be ready.

Then the report suggests that the nondangerous activities should be licensed by the international authority under a system which would prescribe the actual construction of the reactor or plant or whatever it may be that would use the fissionable material for the production of power. Note that the production of power in this secondary use is different from the production of power in the primary use, because in the primary factory you are both producing power and producing fissionable materials. In the second type of factory, the nondangerous factory, you are taking the fissinonable material and using it as a sort of fuel, something which is consumed and used up. In that type of plant, a license can be issued to build a certain kind of reactor. The license would describe how it should be constructed, the authority would supervise its construction, and it would be so constructed that you could not get the fissionable material out of it to make bombs or more fissionable materials except by tearing it to pieces. It is no great trick to supervise that sort of plant, because all you have to do is look at the power dials. If the plant is producing power and the fissionable material is inside it, it will show on the dials. If it is not producing power, something suspicious has happened.

A nation could of course tear one of these plants apart. Again, if the other parts of your control system were effective, it would take at least a year and possibly longer to take the denatured material, build a factory to produce something from it and use it for hostile purposes.

International Authority Should Lead in Research

The report then recommends that the international authority should be in the forefront of experimentation in the field of explosives. Some people have asked: why not forget all that? Why not say that nobody may do it? To say that is, again, to enter into the field of illusion. It is only by knowing more about developments than anyone else that this international authority can stay in the forefront of experimentation, then you would know what dangerous things could develop and what to look for.

That is the general plan that the board of consultants has put forward. Its members know that there are tremendous difficulties of all sorts in this plan. We should regard it as one would regard a preliminary sketch by an architect of a building which he wishes to build, as distinguished from the final blueprints which have all the construction and all the planning and all the material set forth in detail. There are hundreds of problems lurking in this field, and all of these problems must be worked out in detail by a competent and extensive staff.

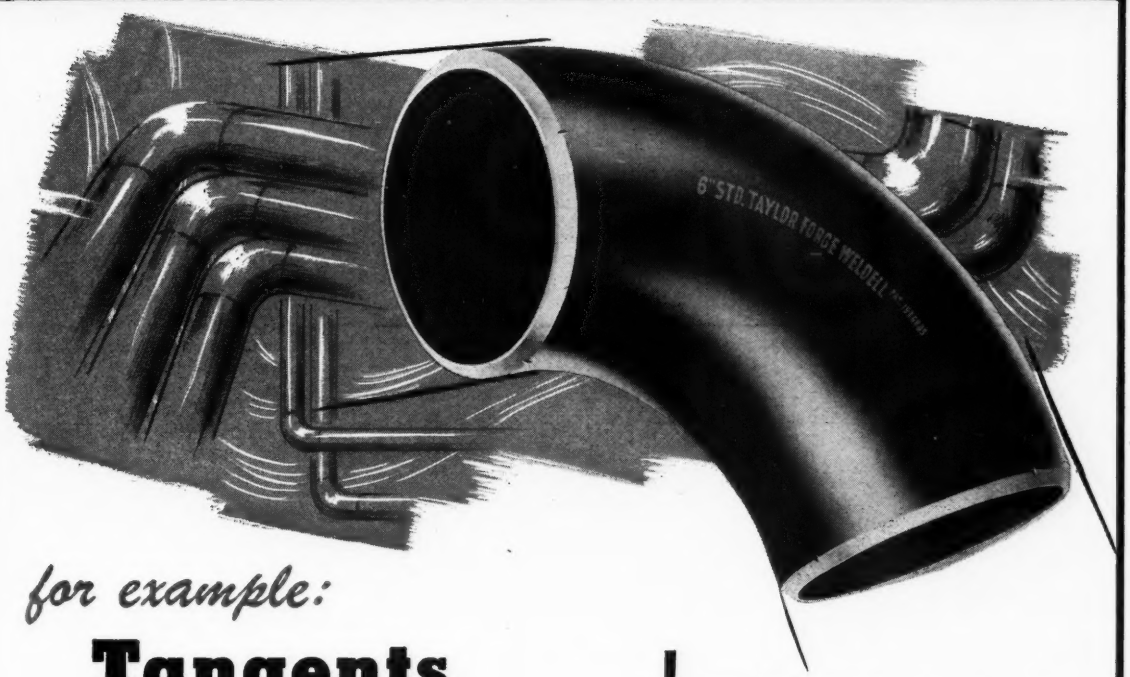
The consultants in making their report were quite conscious of the difficulties of negotiation lying ahead. They did not undertake to go into that field. There is much latitude in this plan. There is latitude in the speed with which you move from one step to another. The board has recommended that we begin, as Alice in Wonderland said, at the beginning and not at the end. The beginning is the field of raw materials. It is a vast field. It will take a long time to organize it, to get the staff that is necessary, to be sure that you have the co-operation of all the nations engaged in this plan before you agree to other steps. Nobody would dream of taking the other steps unless you were satisfied that this first one could be done effectively.

Importance of Interlocking Safeguards

There is one thing which the board evidently feels very strongly about. That is the plan of interlocking safeguards. There is no one part of this plant which alone gives any security whatever. The security comes entirely from the fact that you have at each stage a remaining measure of protection. The raw materials may,

(*Continued on page 160*)

WeldELLS



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Plumbing and Air Conditioning in TVA Hydroelectric Plants

By **H. J. PETERSEN** Head Mechanical Engineer, Tennessee Valley Authority

Design, installation follow Government Code . . . Mixing valves and mixing faucets protect against scalding . . . Drinking water supplied by self-contained water coolers . . . Extra heavy, hard copper tubing used for sanitary water service . . . Water hammer protection by air chambers . . . Pollution prevented by installation of vacuum breakers . . . Septic tanks installed . . . Insulation of hot water piping . . . Details of air conditioning systems for human comfort and for electrical equipment

IN GENERAL, design of the plumbing systems in the hydro plants of the Authority follows the "Recommended Minimum Requirements for Plumbing" established by the Subcommittee on Plumbing of the U. S. Department of Commerce.

Water closets and urinals are provided with flush valves, with those on the urinals being foot-operated. All lavatories are equipped with mixing faucets. Hot water is supplied by thermostatic-controlled tanks with immersion-type elements. These tanks vary in size from 10 to 120 gal. Where the hot-water lines are of considerable length, a small circulating pump is installed; however, in some instances it has been found more economical to purchase more than one heater, thus eliminating long runs of piping. A mixing valve is used in the showers to prevent the possibility of scalding. Drinking water is furnished by self-contained electric coolers located throughout each plant. Wall fountains supplied with chilled water from the remote connections on the water coolers are also used. Acid-resisting, enameled, cast-iron sinks have replaced stoneware sinks which were used in the battery rooms of some of the earlier hydro plants.

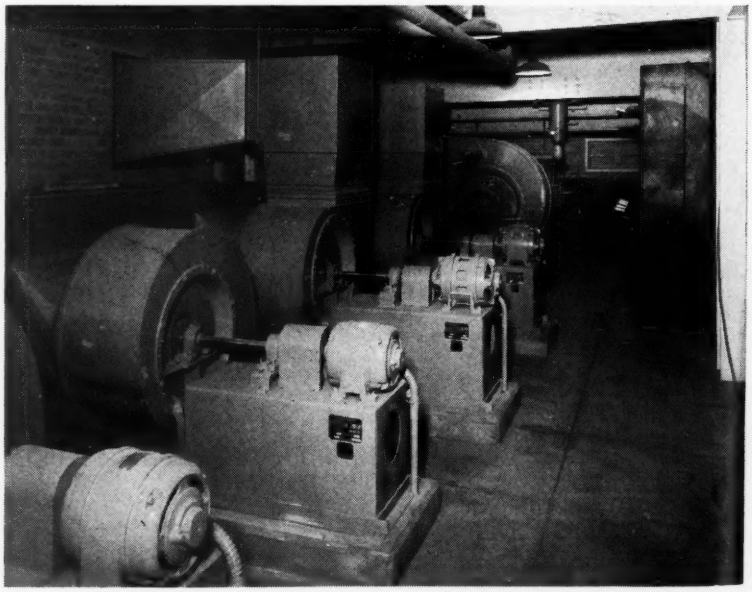
Type K, extra-heavy, hard-copper tubing with solder-joint fittings is used for all sanitary-water service because its small additional cost is justified by its longer life and its ease of installation. Air chambers 18 in. long are installed as close to the fixtures as possible to absorb the surges caused by quick-closing faucets or valves. Water pressures are maintained at approximately 50 psi, with no pressures exceeding 85 psi at a fixture. Excessive pressure results in leakage, water hammer, and high maintenance costs. Valves are provided at each fixture to permit repairs without shutting off a whole group of fixtures. Vacuum breakers are installed on all fixtures that are directly connected to the water supply to prevent polluted water from being siphoned into the water lines. Although ordinarily the pressure in the water lines prevents the entrance of polluted water, sometimes a partial vacuum occurs which causes siphoning unless vacuum breakers are installed. Floor drains in the toilet rooms have been eliminated in the later plants because they are so infrequently used that water evaporates in the traps and sewer gas enters the room.

All exposed soil and waste lines are standard-weight galvanized, wrought-iron pipe with black screwed cast-iron drainage fittings. Extra-heavy cast-iron soil pipe and fittings are used for embedded lines. Galvanized wrought-iron pipe with black malleable-iron fittings is used for vent lines; where possible, the vents are all connected to the main vent stack to reduce the number of pipes projecting above the roof. A septic tank is installed in each plant with effluent discharged to tailwater.

Hot-water piping is insulated with standard molded 3-ft sections of 6-ply preshrunk corrugated asbestos paper, 1 in. thick, and covered with 8-oz canvas pasted on. Fittings in hot-water lines are covered with insulating cement.

Heating, Ventilating, and Air Conditioning

Since the powerhouses are relatively large, with limited occupancy, and the materials of construction are such as to absorb large quantities of heat, the power requirements for general heating to comfort conditions are greater than can be justified. Conse-



View of an exhaust fan room in one of the TVA hydroelectric plants

From a paper entitled Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, presented before Spring Meeting, ASME, Chattanooga, Tenn., April 1946. To be published in full in ASME Transactions.

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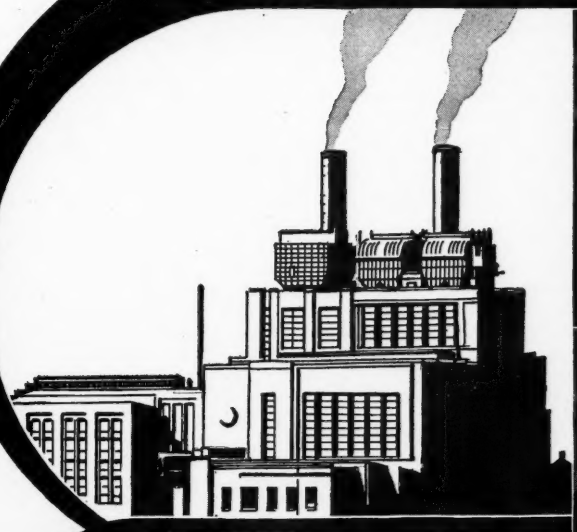
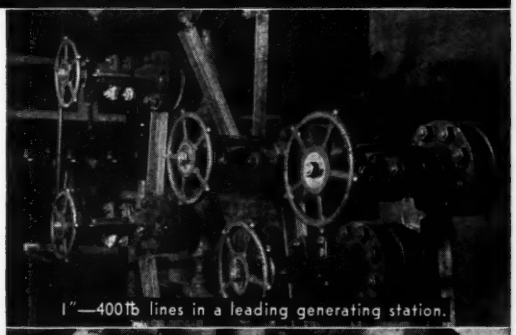
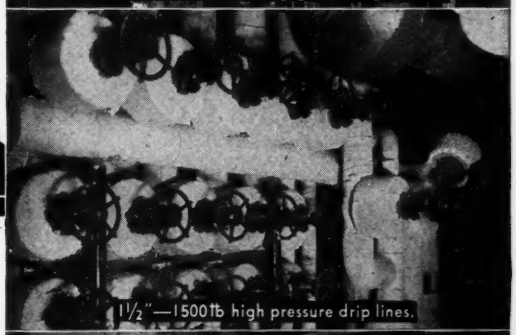
DROP FORGED STEEL VALVES, FITTINGS & FLANGES FOR STEAM GENERATING PLANTS

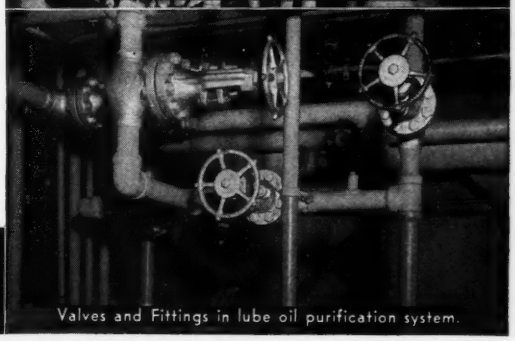




1"—400 lb lines in a leading generating station.



1½"—1500 lb high pressure drip lines.



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quently, only those areas where attendance is required are heated to 72 F, while the rest of the spaces are heated only as required for the relief of dampness or excessive chill.

All heating is by electric-resistance heaters. Except for the air-conditioned areas, heaters, in general, are thermostat-controlled, fan-type, 440-volt three-phase units, with auxiliary on-off-auto manual switches. In some of the smaller areas 220-volt, single-phase, thermostat-controlled heaters are used. They are either gravity convection heaters recessed in the walls or suspended fan units as space or architectural considerations may require. In addition to these permanent heaters, outlets are provided throughout each powerhouse to which portable electric heaters may be connected as desired. In some of the powerhouses air used for ventilating electrical equipment is recirculated, thus utilizing the heat dissipated. In one plant this reclaimed heat amounted to more than 100 kw.

Ventilation is provided in the several areas of each plant according to the need for human comfort, for the dissipation of heat from electrical equipment and solar radiation on roofs, walls, and decks and for the relief of dampness. In a number of plants where the arrangement and design of the electrical equipment require, parts of the electrical apparatus, including the main generator leads, are ventilated to prevent damage from overheating. Ventilation is provided in the tunnels and lower galleries for the relief of excessively damp and stagnant conditions.

The scheme of ventilation is a problem which must be solved in each individual plant. The usual practice of the Authority is to introduce air into the generator room and lower parts of the service bay and to exhaust this air through the other spaces to be ventilated by separate fans. In a few plants the fresh air is introduced by gravity, but in most powerhouses a number of supply fans are employed. The arrangement of each powerhouse usually is such that most of the more important spaces adjoin the generator room or are connected to it by open passages. These spaces are grouped together according to location and similarity of ventilating requirements into a number of groups, and each group is served by a separate exhaust system. In the semi-enclosed type of hydro plant, where the intake deck is just above the generators, the excess heat from the generators and from solar radiation on the deck above escapes through louvers in the generator hatch covers over the machines. These louvers may be closed in winter, if desired, to conserve heat.

For convenience of maintenance and for economy of space, all the fans in the powerhouse are grouped usually into two separate fan stations. Photo shows an exhaust-fan station for one plant. It may be seen from this view that both direct-connected and belt-driven fans are used. When the discharge pressure is fairly constant, fans with forward-curved blades at low rotative speeds are sometimes used. However, most of the fans used by the Authority have backward-curved blades because of their high efficiencies over a wide range of performances and because of the non-overloading characteristic of that type of blade. It is also better suited to high speeds and hence more adaptable to direct connection. Inlet dampers are used where close control of the discharge pressure or of the delivery of a fan is desired. These dampers are operated by either a pneumatic or an electric motor actuated by the discharge pressure. Resilient bases, usually rubber-mounted, are used under fans when it is necessary to eliminate vibration or reduce noise.

Air Conditioning

Air conditioning is provided in certain spaces of each powerhouse for the protection of delicate electrical equipment and for human comfort. Because of variations in the heating and cooling requirements of the different parts of the powerhouse, the air-conditioning spaces usually are divided into three systems. One system serves the control room and its related spaces, another system serves the office areas, while the third system serves the public spaces, including the lobby and entrance vestibules. Other spaces, such as the telephone-equipment room, the laboratory, the assembly room, and the first-aid station, are served by one or more of the three systems. The control-room-system areas are grouped together because with their limited outside exposures and heavy heat losses from electrical equipment, they may require cooling at times when the other spaces require heating. The office system areas are served together because of similarity of exposure and thermal load, and the spaces served by the public-spaces system are grouped together because of their proximity.

The individual air-conditioning systems may be used for ventilating, heating and humidifying, or cooling and dehumidifying as required. Electric blast heaters are used for heating, and their operation is thermostatically regulated with auxiliary manual control. Humidification is provided by discharge of live steam generated by an electric immersion heater in an open pan in the plenum of each system. Cooling is by finned-type surface coolers, using chilled water in the coils. In the high-head plants where storage water is available at 55 F or less, lake water is used; in the other plants water is chilled by mechanical refrigeration.

Each of the air-conditioning systems can be placed on the heating, cooling, or ventilating cycles as desired and the control and operation of each is independent, that is, one system may be operating on the heating cycle while the other systems are on the cooling or ventilating cycles. Each system is complete with fan, electric blast heaters, humidifier, cooling coils, and filters, together with the manual, thermostatic, and other automatic control and safety devices necessary for its operation. Fans for air conditioning have two-speed motors or adjustable variable-speed motors, with the low speed used for the heating cycle and the high speed used for the cooling cycle.

The air filters are of the dry-filter type with filtering medium of paper, felted cotton, or felted glass fiber. Cell-type construction is used, and spare cells and filter media are provided at each plant.

In those plants having mechanical refrigeration, one water-chilling system serves all air-conditioning systems. The water-cooling equipment consists of one or more single-acting, multi-cylinder refrigerant compressors, a shell-and-tube-type water cooler, and a shell-and-tube-type condenser, all piped together and assembled as a unit. Welded joints are preferred for the steel refrigerant piping to minimize leakage, but tongue-and-groove-type flanged joints are used for connections to the compressor and refrigerant specialties. Piping smaller than 1 in. is usually extra-heavy copper tubing with sweated joints. The refrigerant is Freon-12 which is nontoxic, noninflammable, and nonexplosive. Lake water, usually supplied by gravity, is used for condensing.

The air-conditioning system in each plant is automatic and in order to prevent excessive starting and stopping of the compressor a separate storage tank of chilled water is provided. Water is circulated from this tank by a small pump which responds to demands for cooling water. The chilled-water piping is insulated with cork, glass fiber, or mineral cork, ice-water thickness, and covered with a sealing tape and compound. Supply ducts are insulated with 1-in. boards of the same material and sealed with an airtight coating. Return-air ducts are not insulated. Fans, tanks, and plenums are insulated as required in the same manner as the ducts.

Contract Awarded for Columbia Basin

A $2,871,796 contract for advancing construction work on the West Canal of the Columbia Basin Reclamation project (Washington) has been awarded, Secretary of the Interior J. A. Krug announced recently.

This contract follows closely that for the Pasco Pumping Plant and canals, which in 1947 will bring Columbia River water to irrigate 6,000 acres of land, the first farm land in the million-acre basin to be made ready by the Bureau of Reclamation for settlement by veterans and others.

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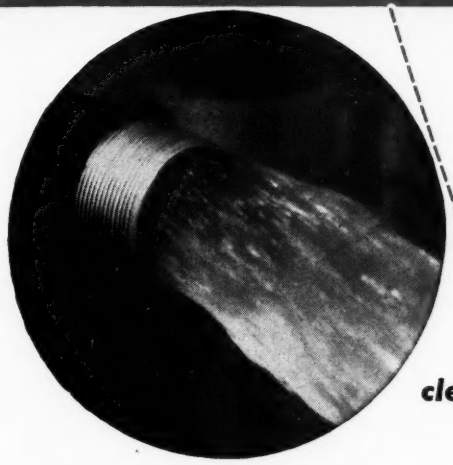

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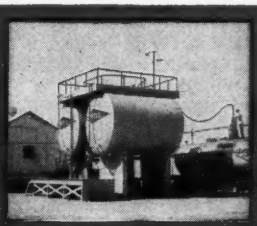

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Diaphragm Control Valves

(*Continued from page 87*)

Actual operating data should always be used to determine valve capacity whenever it can be obtained.

On first thought a rangeability of flow of 50 to 1 might seem to be required very infrequently. However, in a class (2) system, decrease in flow greatly increases pressure drop or energy which must be absorbed by the control valve. Let us assume that maximum flow is 100 gpm at 9 lb pressure drop and that minimum flow is 5 gpm at 49 lb pressure drop. Under these conditions the port area change is calculated by multiplying ratio of maximum to minimum flow by the ratio of the square root of the corresponding pressure drops. The calculation is as follows:

$$\frac{100}{5} \times \frac{\sqrt{49}}{\sqrt{9}} = \frac{140}{3} = \frac{46 \text{ plus}}{1}$$

The above conditions are just within the possibility of a valve with a rangeability of 50 to 1.

The effect of variation in specific gravity in valve calculations is exactly parallel to flow measurement calculations. As it is a square root function, an error of 0.1 at a specific gravity of 1.0 for either liquid or gas would cause an error of only 5 per cent while the same error of 0.1 at a specific gravity of 0.5 would cause an error of 20 per cent.

Effects of Viscosity and Vaporization

Current research has developed some quantitative information for certain specific viscous fluids. Usual practice, however, is to calculate the valve size for very viscous fluids in the conventional manner and then make the valve one size larger.

Several methods are in general use for valve selection involving flashing fluids or vaporization.

(1) The liquid and vapor volume are calculated separately and C_V for each condition determined. The valve size selected has an area or C_V equal to the sum of the two conditions. This method assumes total vaporization in the valve body and is generally on the large side.

(2) Calculate the C_V for the total quantity of liquid only and then choose a valve one size larger. Make definitely certain that the downstream piping is adequate in size. This method assumes that vaporization begins in the valve body, but reaches equilibrium at some point in the line downstream from the control valve. This latter method is most economical and generally satisfactory.

(3) The latest method is to make a heat balance.

How to Analyze the System as a Whole

So far, our discussion has concentrated most of our thinking on the control valve and its characteristics and has considered only in a very sketchy manner the system as a whole. Actually, our method of handling valve selection is analogous to an electrical engineer selecting a rheostat without knowing his complete circuit. Let us assume a single system in which the valve is in series with a fixed resistance which will simulate friction loss in pipe, valves, fittings, exchangers, etc.:

P_1 Fixed resistance — P_2 Variable — P_3 resistance

If we know the normal flow rate, fluid and pressures P_1, P_2 and P_3, we can calculate a line coefficient which will parallel the valve coefficient C_V. The line coefficient can be defined as the capacity of the system, exclusive of the control valve in gpm of water at 1 psi.

The line coefficient C_L and valve coefficient C_V can be combined in the following equation to represent the flow in the system:

$$\text{Gpm} = C_V \sqrt{(P_2 - P_3)} = C_L \sqrt{(P_1 - P_2)}$$

$$\text{Gpm} = C_V \sqrt{\{(P_1 - P_3)\ [C_{L^2}/(C_{V^2} + C_{L^2})]\}}$$

where

Gpm = Gpm of fluid

C_V = Valve coefficient

C_L = Line coefficient

P_1 = System inlet pressure psi absolute

P_3 = System outlet pressure psi absolute

The above equation merely states mathematically that the flow through the valve is equal to the flow through the balance of the system. This equation also assumes that the only variable in the system is the position of the valve plug in the valve body. If we plot the valve coefficient C_V in logarithmic coördinates and valve lift percentage in linear coördinates, we can select values of C_V at various percentages of lift, including $C_{V^{max}}$ or 100 per cent lift.

Let us assume some actual operating conditions. We can assume specifically that we have 100 psi pressure drop across our system with a normal flow rate of 100 units, which can be, for example, gpm. Let us assume that we can maintain the 100-lb pressure drop under any and all conditions. Let us further assume that, at normal flow rate, the pressure drop across the control valve will be 36 lb and across the balance of the system 64 lb. This ties in with my foregoing suggestion that one-third of the total system drop should be absorbed by the control valve.

Let us work out the valve coefficient for a "normal" valve, and further assume that the flow curve is an equal percentage flow curve with a 4 per cent change in flow for each 1 per cent change in lift, which is roughly equivalent to a valve with a 50-1 rangeability. Let us further assume that the fluid is water, to eliminate the specific gravity factor.

Based on the above information, let us calculate the valve coefficient C_V and the line coefficient C_L.

$C_V = 100 \text{ gpm}/\sqrt{36} = 16.7$

$C_L = 100/\sqrt{64} = 12.5$

You will note from the above calculation that the normal valve coefficient calculates 16.7 for this assumed system. If you will recall Fig. 7, the $C_{V^{max}}$ for a 1¼ in. valve is 16. Therefore, let us say for this system that the normal valve is practically a 1¼ in. valve. The line coefficient C_L is 12.5. From the Cameron Hydraulic Data Book or other such source, we find that a line coefficient of 12.5 is equivalent to 410 ft of 2 in. pipe.

In addition to seeing what a 1¼ in. valve will do in series with 410 ft of 2 in. pipe, let us install a 1 in. (0.6 normal), a 1½ in. (1.6 normal) and a 2 in. (2.5 normal) valve in the same piping system. What we shall then be doing is to note the effect of valves smaller than line size up to a valve equal to line size in such a pipe system. In addition to these valves, let us include an infinitely small valve and an infinitely large valve.

In view of the fact that curves are not available, we have calculated the conditions in the assumed system with the valve wide open, or at maximum C_V. This tabulation points out very definitely what happens with valves of various sizes in a given piping system.

Valve Size	C_V	Valve Drop psi	C_L	Line Drop psi	Flow Gpm
Inf. Small ..	0	100	12.5	0	0
(0.6 N) 1"...	10	61	12.5	39	78
Normal 1¼"...	16	36	12.5	64	100
(1.6 N) 1½".	25	20	12.5	80	112
(2.5 N) 2"...	40	8.8	12.5	91.2	119
Inf. Large		0	12.5	100	125

Obviously, with an infinitely small valve, pressure drop is concentrated across the control valve; the valve coefficient is zero, the line coefficient is 12.5; as there is no flow in the system, there is no pressure drop across the line.

The use of an infinitely large valve with an infinitely large C_V simply means that we have no pressure drop across the valve and are concentrating the entire 100 lb across the line. Under these conditions, the maximum flow possible in this system is 125 gpm.

What I am trying to say is simply that with a given piping system, it is not economical to attempt to increase system capacity by increasing valve size beyond the normal size. The normal size can be calculated mathematically, if necessary, but is rationally generally several sizes smaller than line size. In increasing the normal valve size to 1.6 times normal, we increase the capacity of the system 12 per cent. By installing a 2.5 times normal valve, or line size valve, we only increase system capacity over the 1.6 times normal valve by an additional 7 per cent, or the net increase over the normal valve of 19 per cent. This table also shows that there is no logic in installing a valve larger than line size, as we only gain an additional 6 per cent capacity by entirely eliminating a pressure drop across the control valve.

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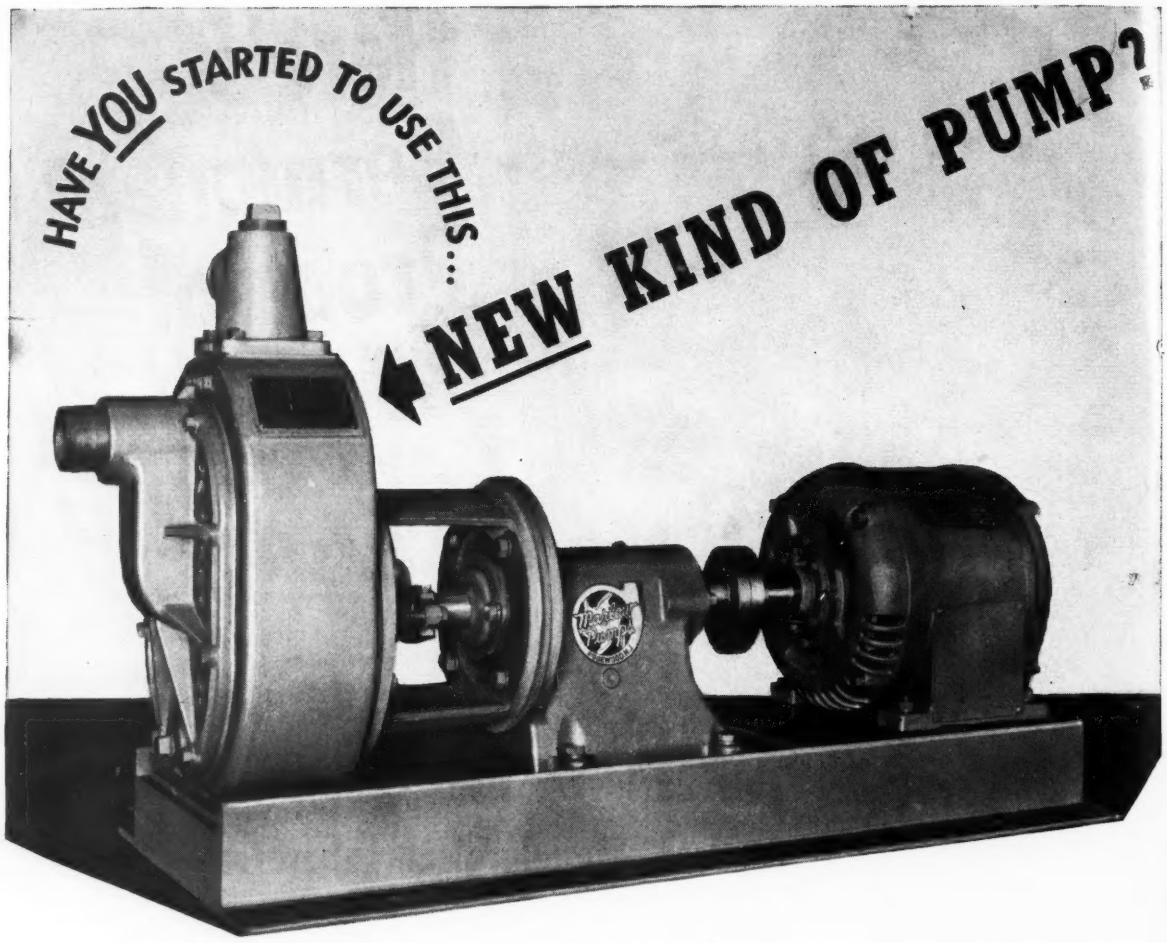

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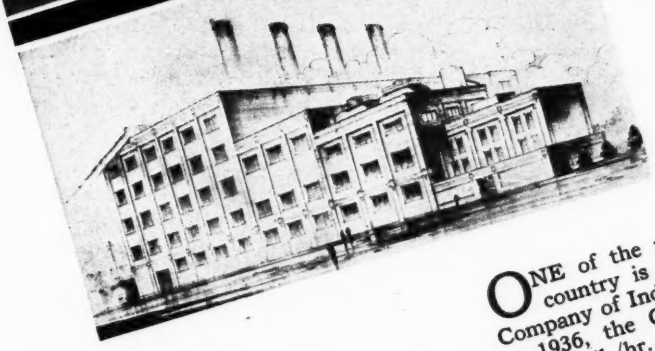

DEAERATORS AT *Indianapolis Power & Light*

ONE of the most progressive utilities in the country is the Indianapolis Power & Light Company of Indianapolis, Indiana. Ten years ago, in 1936, the Cochrane Corporation furnished a 650,000 lb/hr. Deaerator, for Section "K" of the C. C. Perry plant. This Cochrane Deaerator heated the entire boiler feed in Section "K" and completely removed dissolved oxygen. Again in 1940 a 400,000 lb/hr. Deaerator was installed in the Harding Street Plant for Unit #3.

Now, as indicated by the architect's drawing shown at the top of the page, the Perry "K" Station is being expanded and another Cochrane Deaerator of 700,000 lb/hr. shown in the illustration below, is being installed. At the same time another 400,000 lb/hr. Cochrane Deaerator is being installed in the Harding Street station for Unit #4.

Cochrane Water Conditioning Apparatus has been a part of Indianapolis Power & Light Company equipment since 1917.

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SECTION "K"

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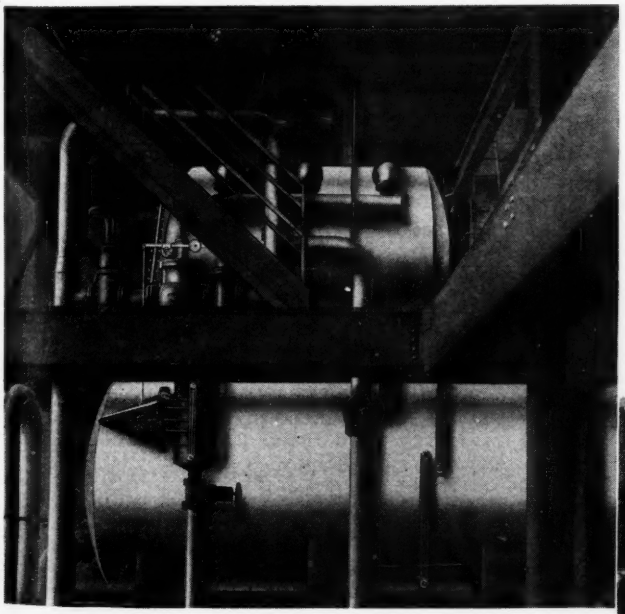
Two 400,000 lb/hr. Cochrane Open Heaters

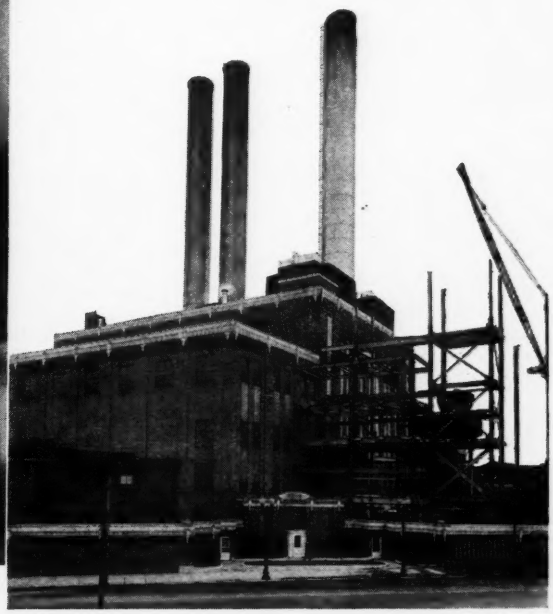
MILL STREET STATION

Two 300,000 lb/hr. Cochrane Open Heaters
One 500,000 lb/hr. Cochrane Open Heater

HARDING STREET STATION

Two 350,000 lb/hr. Cochrane Open Type Heaters
One 400,000 lb/hr. Cochrane Deaerating Heater





NEWS from THE FIELD

Steel Industry Needs Scrap Metal

ALTHOUGH THE operating rate of steel companies during the summer months has been tapering off during recent weeks, according to the American Iron and Steel Institute, due to dwindling supply of scrap metal. This condition has been brought about as the result of many factors in the industry, principal among which are the following:

The already low supply of scrap was reduced still further during the coal strike last spring which forced the industry to use larger percentages of scrap than normal in furnace charges because no coal was available to make pig iron.

Much of the scrap normally comes from the consuming and fabricating industries whose activities have been curtailed by labor strikes, thus cutting that supply drastically.

Flow of scrap has been hampered by the uncertain price situation. The reinstatement of OPA price ceilings, however, should, it is hoped, stabilize prices.

Potential buyers of new equipment have been forced to hold on to their old machinery because the new is not available. This applies to the railroads, power plants, factories, automobile users, and farmers.

The Institute reports that normally scrap makes up 50 per cent of the charge in an open hearth furnace from which by far the greatest proportion of all steel comes. By using more pig iron in place of scrap during July, the steel industry was able to increase its rate but the limit has about been reached in that respect and 25 to 30 open hearth furnaces were idle for lack of scrap on the first of August as compared with 12 on July 1. During July receipts of scrap by mills fell from an average of 60 to 40 per cent of requirements.

With prices frozen there seems to be little advantage in allowing scrap to accumulate around power plants and the quicker this scrap gets back to the furnaces the sooner industry in general will get new equipment that depends upon steel for its manufacture. Power plants throughout the country did a rather thorough job in getting rid of their accumulations of scrap during the war, and it is not likely that any great amount has collected since as comparatively few plants have been able to replace their badly worn and obsolete equipment with new units. The need for scrap, however, is urgent and every pound that can be sold back to the industry will help that much in the production of needed equipment.

Seventeenth National Power Show

THIS YEAR THE POWER SHOW, officially known as the 17th National Exposition of Power and Mechanical Engineering, to be held in New York City, December 2 to 7, has an unusual appeal. In many respects, engineering progress has been stifled since the 1920's. The country since then has experienced practically a ten-year period of economic depression which compelled entrenchment, repression, hedging and extreme economy on the part of every going concern in industry.

In addition, during the past half decade, industry has been spending its energy in an effort to put an end to the war as quickly as possible. In many lines manufacturer's designs were changed but very little in order to get out mass production of thoroughly proven equipment for which the factories were equipped, engineers knowing full well that better equipment could be built if time had permitted the tooling up and perfecting of design details which necessarily accompanies the production and successful use of machinery designed along new principles.

So, for 15 years the power plants of the country have, in large measure, been at a standstill regarding the application of new scientific principles to the production and use of power. All that is now past.

This Show, no doubt, will give an opportunity to study the possibilities of applying exhibited equipment to the problems that are likely to come up for solution. Many details have changed in recent years and need to be examined. Structurally, equipment must be able to stand the strain of operation, new materials and new fabricating methods need careful study. So do bearings, lubrication methods, and points of wear which are frequent causes of trouble. Rust and erosion are annoying twins in hampering the operation and maintenance of power equipment, and modern science is doing a lot in the choice of materials and their protection to combat these destroyers of economy and safety.

Other wastes that exist in power plants come about through faulty seals supposed to prevent leaks of liquids, gases and precious fluids like steam and ammonia vapor. With the higher pressures and temperatures being used now, many changes have been made in the design of joints, stuffing boxes and glands and the materials used to form seals. Manufacturers, no doubt, will be exhibiting a wide variety of new products to correct these losses.

Most certainly many of the revolutionary developments that have been devised by scientists and put into actual working equipment by engineers will be on exhibit. Under this designation would be included instruments and controls employing electronic principles, gas turbines, applications of X-rays, supersonics, microscopy, thermometry, heat radiation, light and sound waves, chemical inhibitors and metallurgy all of which are helping the engineer to do a better job in the generation of power.

Electrical Engineering Exposition

MANY EXHIBITS at the forthcoming Electrical Engineering Exposition will be on view exclusively at that display, which is the only one devoted to the interests of large scale production and distribution of electrical energy. The Exposition is to be held in the 71st Regiment Armory, New York City, concurrently with the Winter Convention of the American Institute of Electrical Engineers, January 27-31 next.

Designed to be of practical information value to designers, constructors and operators in the engineering of large electrical installations, the Exposition will feature equipment of the newest order of design and construction, the products of engineering research. It will cover the several departments of the field, including electric generating and power station equipment, transmission lines and networks, sub-stations and incidental items up to the consumer's meter and many that are used within consumer's plant.

COMING EVENTS

American Welding Society— 1946 annual meeting to be held in New York City, October 24.

Joint Fuels Conference — ASME-AIME Joint Fuels Conference; to be held at the Bellevue-Stratford Hotel, Philadelphia, October 24 and 25.

Seventh Annual Water Conference— Sponsored by the Engineers Society of Western Pennsylvania; to be held in Pittsburgh October 28 to 30, with headquarters at the Hotel William Penn.

Refrigeration, Air Conditioning Show —Sponsored by Refrigeration Equipment Manufacturers Assn.; to be held in Cleveland, October 29 to November 1, in the Public Auditorium.

American Welding Society— 1946 annual meeting (reassembly) to be held in Atlantic City, November 17 to 22; headquarters at Municipal Auditorium.

National Metal Congress and Exposition—To be held in Atlantic City, November 17 to 22, headquarters at Municipal Auditorium.

Power Show—17th National Exposition of Power and Mechanical Engineering; to be held in New York City, at the Grand Central Palace, December 2 to 7.

ASME—American Society of Mechanical Engineers; mid-winter meeting, to be held December 2 to 7.

Stress Analysis—Annual meeting of the Society for Experimental Stress Analysis to be held in New York City, December 9, 10 and 11; headquarters at the Hotel New Yorker.

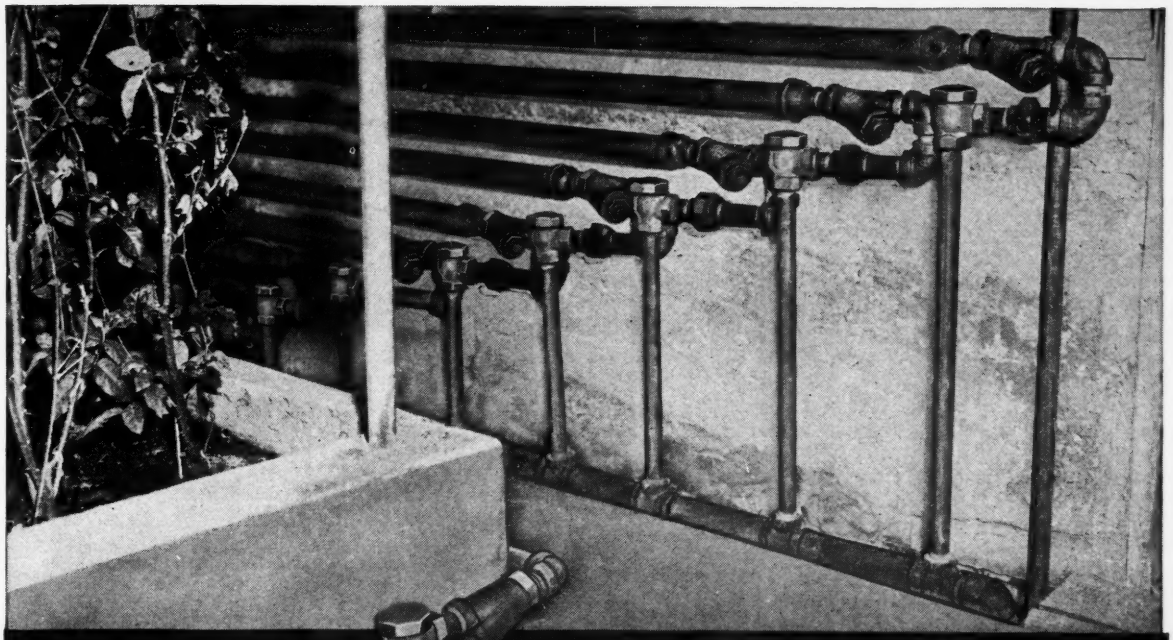
Heating and Ventilating Exposition— 7th International Heating and Ventilating Exposition; to be held January 27 to 31 in Cleveland at Lakeside Hall.

Electrical Engineering Exposition— Annual show (Postponed since 1941) to be held in New York City, January 27 to 31; headquarters at 71st Regiment Armory, Park Ave. and 34th St.

AIEE—American Institute of Electrical Engineers; winter convention to be held January 27 to 31.

ASTM—1947 Spring Meeting and Committee Week of the American Society for Testing Materials; to be held in Philadelphia, February 24 through 28, with headquarters at the Benjamin Franklin Hotel.

ASTM—1947 Annual Meeting; to be held in Atlantic City, June 16 through 20, with headquarters at Chalfonte-Haddon Hall.



SAVED . . . 30% of Fuel—

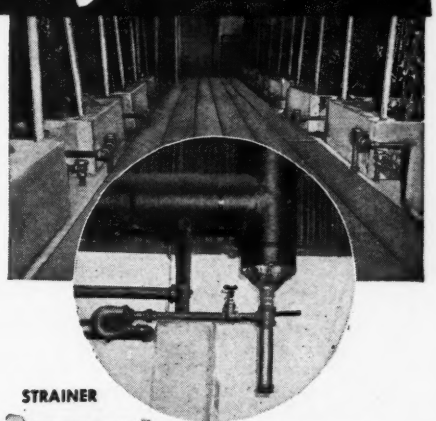
—60% ON MAKE-UP WATER

This large Long Island greenhouse was like many industrial plants. It grew like Topsy—and ended up with no over-all heating layout, unsatisfactory service and obvious inefficiencies.

Then, Sarco Engineers and the contractor laid out a modern system—with a Sarco Radiator Trap and Strainer on each of the long steam lines.

The savings in fuel are double-checked by the saving in make-up water. The value of reliable, even and continuous heat cannot be over-estimated.

In thousands of apartments, commercial and industrial buildings the same inefficiencies exist. Your engineer can tell you what is wrong—the nearest Sarco representative can work out a combination of steam traps and temperature control which will place your operating services and costs on a par with the best there is. Ask for Catalog No. 100.



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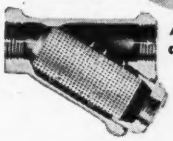
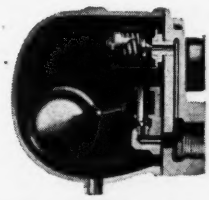


A radiator trap for each bay—and float traps on ends of mains.

RADIATOR TRAP



FLOAT-THERMOSTATIC TRAP

136

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Fuels Conference Program

FOLLOWING IS the program for the ASME-AIME Joint Fuels Conference to be held at the Bellevue-Stratford Hotel, Philadelphia, October 24 and 25:

Morning Session, Oct. 24

C. S. Gladden, Departmental Engr., Cherokee Ordnance Works, Hayden Chemical Corp., "Burning Anthracite on Chain Grates."

M. G. Driessen, Chief, Mining Research Department, Staatsmijnen, Limberg, Netherlands, "Fine Coal Cleaning in the Netherlands."

C. C. Russell, Chemical Engr., Koppers Co., Research Dept., "Studies of Coal Plasticity as Related to Coal Carbonization."

Afternoon Session

C. C. Wright, Chief Div. Fuel Tech., The Pennsylvania State College, "Anthracite in Gas Producers."

R. C. Johnson, Vice President, Anthracite Institute, "Combustion of Anthracite in Glass Tubes."

C. H. Frick, Plant Betterment Engr., Power & Light Co., Allentown, "Grinding of Anthracite for Pulverized Fuel."

Morning Session, Oct. 25

D. R. Mitchell, Secretary, Pennsylvania State College, "Heavy Duty Equipment Used in Trucking, Blasting, Drilling, etc., in Stripping."

G. A. Roos, Manager, Philadelphia & Reading, "Newkirk Tunnel Mining Practices."

H. F. Hebley, Director of Research, Pittsburgh Coal Co., "Mining Pennsylvania Bituminous Coal."

Afternoon Session

E. C. Payne, Consulting Engineer, Consolidation Coal Co., Panel Discussion: "Why So Many Sizes of Coal?"

Heating and Ventilating Exposition

ADVANCE NEWS of the 7th International Heating and Ventilating Exposition indicates that it will reveal technical progress in the great variety of equipment eligible for display. Applications for space in the air-conditioning exposition, as it is often called, forecast an early assignment of all space available at Lakeside Hall, Cleveland, for the exposition dates, January 27-31 next, and also promise well-balanced enrollments in all departments.

Paced by the American Society of Heating and Ventilating Engineers, which will hold its 53rd Annual Meeting concurrently, the industry has profited by extensive experience gained during the war to bring forth innovations and improvements of many kinds. Extensive research conducted by the Society combined with the manufacturers' product development work have provided new solutions for numerous installation problems, as reflected in new items of equipment.

Refrigeration Show

THE MECHANICAL refrigeration and air conditioning industry this fall will disclose the latest industrial applications of its products at the industry's first national exposition in nearly six years.

Included in the anticipated 300 displays at the Fourth All-Industry Refrigeration and Air Conditioning Exposition, which will be held in the Cleveland Public Auditorium, October 29 to November 1, will be many exhibits of new equipment designed especially to aid manufacturing processes in various types of industries. Other displays will feature new methods of applying the principles of low temperature mechanical refrigeration and modern air conditioning as useful industrial tools.

Nomenclature Standardization

IN CONNECTION WITH the effort to standardize abbreviations, graphical and letter symbols used by the air conditioning and refrigeration industry, the American Standards Assn. Nomenclature Committee B53, sponsored by the American Society of Refrigerating Engineers, is endeavoring to find out just what is now being used by the industry.

It was felt by the committee personnel that the best way to achieve standardization of the various abbreviations and symbols was to obtain from the industry samples of what are now being used, carefully study and compare them, and then arrive at a decision as to best ones to adopt as standards.

Accordingly, the Committee is writing a letter to two hundred representative firms engaged in refrigeration and air conditioning, asking them for the following information: 1. What graphical symbols do you use in representing refrigeration equipment within the refrigeration cycle? 2. What letter symbols do you use? 3. What abbreviations do you use? While the recipients of the letter were selected as being representative of the industry, the inquiry is by no means limited to them, and the Committee hopes that any firm or individual that is interested, whether or not they receive a letter, will send in a set of symbols and abbreviations they use together with any suggestions they may care to offer. Communications should be addressed to D. F. Hayes, Secretary, Nomenclature Committee B53, American Standards Association, 70 East 45th Street, New York 17, N.Y.

Market Studies of Refrigeration

MARKET STUDIES of important industries to determine the potential requirements for refrigeration and air conditioning equipment will be undertaken by the Air Conditioning and Refrigerating Machinery Assn., representing many of the larger manufacturers of air conditioning and refrigerating equipment.

Announcement of the establishment of the research and statistical department to conduct this work was made by William B. Henderson, executive vice president of the association. The object of the department will be to maintain current information on the rapidly expanding use of refrigeration and air conditoning machinery and to conduct special studies by assembling, collating and analyzing all available data bearing on the use and the probable new demands for refrigeration and air conditioning machinery.

Early attention will be given by the new department to a survey of the food industry, one of the largest users of refrigerating and air conditioning equipment. The first phase of this work, which is already under way, deals with the dairy industry and its sales potential for refrigeration equipment. A part of this study dealing with dairy farming already has been completed.

1946-47 Officers of Smoke Prevention Assn.

THE FOLLOWING OFFICERS were elected at the 39th Annual Meeting of the Smoke Prevention Association of America, Inc., held at the Nicollet Hotel, Minneapolis, Minn.: Sumner B. Ely, President (Supt. of Smoke Regulation, Pittsburgh, Pa.); Eugene D. Benton, First Vice-President (Battelle Memorial Institute, Columbus, Ohio); Cyrus J. Sokel, Second Vice-President (Belt Ry. Co. of Chicago, Clearing, Ill.); W. E. E. Koepler, Public Relations Director (Pocahontas Operators Assn., Bluefield, W.Va.); Frank A. Chambers, Secy.-Treas. (Chief Smoke Inspector, Chicago, Ill.); Guy C. Hess, Sergeant-at-Arms (Pennsylvania R. R., Jersey City, N. J.).

Conference On Farm Electrification

A NEW and extensive program to spur rural electrification through joint efforts of agricultural societies, power companies, farm equipment manufacturers, farm organizations and educational groups will be initiated this fall at the first National Farm Electrification Conference, to be held in Chicago, November 7 and 8.

The Conference, first of its kind to be held on a nationwide basis, is expected to attract hundreds of individuals and groups interested in raising farm living standards, and reducing farm production costs by increasing the profitable uses of electricity on farms. Research into new farm uses of electricity, cooperative activities designed to improve farm applications of electric service, and educational programs to teach the farmer the advantages of newly developed methods will all be employed in the national program, it was said. The program will be further developed at the meeting in November.

More than $18,000,000 in equipment and construction contracts have been granted by the Bureau of Reclamation for Grand Coulee Dam and the Columbia Basin Irrigation Project since V-J Day.

The Prize Awards Committee of the Edison Electric Institute has announced the resumption of the Thomas W. Martin Rural Electrification Award, which was suspended during the war years.

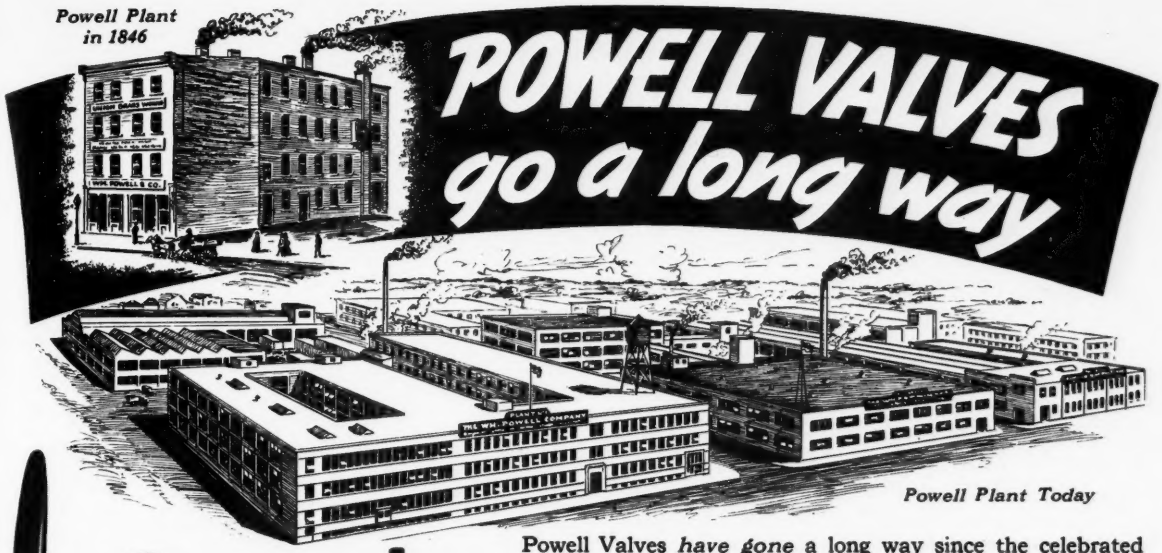
The American Society for Metals today announced that Dr. Rufus E. Zimmerman has been elected to receive the Society's Medal for the Advancement of Research for 1946. Dr. Zimmerman is vice-president in charge of Research and Technology of the United States Steel Corp. of Delaware.

Obituaries

T. W. Clark

T. W. CLARK, who has been associated with Strong, Carlisle & Hammond Co. for over 30 years, recently died suddenly at his home in Corry, Pa.

Mr. Clark represented the company in New York, Chicago, and had traveled in the West for the past several years as a sales engineering representative for the Strong Steam Specialties Division. More recently he was connected with the engineering department at the factory. He is survived by his wife.



Powell Valves *have gone* a long way since the celebrated Powell "Star" Regrinding Globe Valve was patented in 1865.

Today, with a notably complete line of valves, which includes every required type, size and design—in bronze, iron, steel and many corrosion-resistant metals and special alloys—Powell Valves *are going* a long way in meeting the flow control requirements of modern industry.

Above all, Powell Valves *go* a long way in actual service, because each valve is designed to give maximum performance under the actual operating conditions it will encounter.

Catalogs on request. Kindly state whether you are chiefly interested in Bronze, Iron, or Cast Steel Valves.

A Powell answer to the demand for higher pressure and higher temperature flow control equipment. This Class 1500-pound Cast Steel Non-return Angle Valve with welding ends, has a 16" outlet and two 12" inlets. Said to be one of the largest of its kind ever built. Because of its special streamline designing, the pressure drop through the valve is reduced to a minimum. Toggle operated.

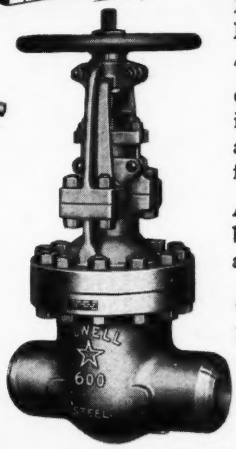


Fig. 6003 W.E.—Class 600-pound Cast Steel Gate Valve with welding ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Powell Cast Steel Valves of all types are available in pressure classes from 150 to 2500 pounds, inclusive.

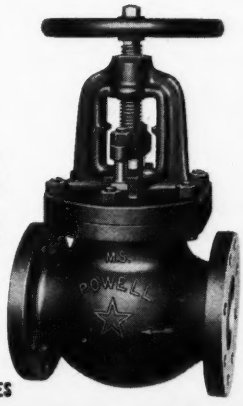


Fig. 241—125-pound Iron Body Bronze Mounted Globe Valve. Flanged ends, outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

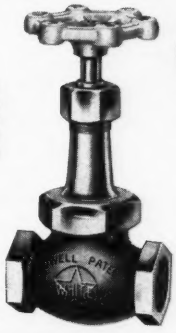
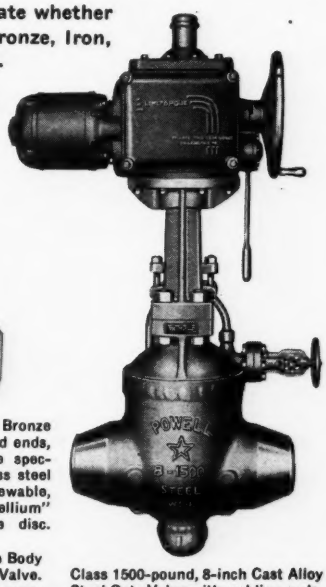


Fig. 1708—200-pound Bronze Globe Valve. Has screwed ends, union bonnet, renewable specially heat treated stainless steel seat and regrindable, renewable, wear resisting "Powellium" nickel-bronze, plug type disc.



Class 1500-pound, 8-inch Cast Alloy Steel Gate Valve with welding ends, welded bonnet and special by-pass. Top-mounted electric motor operator provides quick, positive opening and closing by remote control.

The Wm. Powell Co.
Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

R/M BRAIDED ASBESTOS ROPE

The doors on furnaces, gas generators, and many other types of equipment require a dense, strong packing that will resist temperatures up to 600° F. and furnish a tight seal.

To meet these conditions, and as a variant from ordinary braided asbestos packing, R/M engineers designed the asbestos rope, shown above. It is furnished either in solid braided construction without a center core, or with a single or double braided asbestos jacket over a twisted asbestos rope center. All types are available either treated or dry, ready for oiling and graphiting in the engine room to the user's specifications.

These different types of braided asbestos ropes are just a few of the hundreds of R/M packings which are available through your authorized R/M distributor. For every type of equipment, for every service, R/M has a specially engineered packing of selected materials and of proved performance.

RAYBESTOS-MANHATTAN, INC.
ASBESTOS TEXTILE AND PACKING DIVISION
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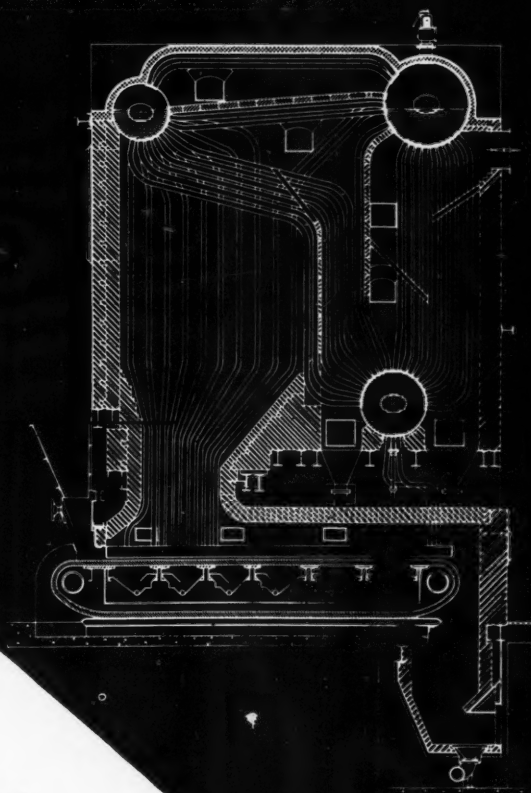
It's "Packed with Satisfaction" when you use R/M

Edge Moor Radiant Boiler



When modernizing present boiler facilities, or building new plants, it will pay you to consider the features of Edge Moor Radiant design. For instance, examine the following:

★ Design flexibility allows the most favorable use of available building space.

★ Ability proved in years of service to steam quickly and to deliver continuous high ratings.

★ 3-drum arrangement provides for large water storage space, a generous steam liberation surface and a quiet offtake drum.

★ Furnace cooling is arranged for the minimum of maintenance as well as efficient operation with the particular fuel to be used.

Edge Moor Radiant Heat Boilers are available in a wide range of capacities, pressures and total temperature requirements. They are adaptable to all fuels and can be supplied with all boiler auxiliaries.

EDGE MOOR IRON WORKS, INC. • Main Office and Works, Edge Moor, Del. BRANCH OFFICES AND AGENTS: 95 River St., Hoboken, N. J. • 7 Water St., Boston, Mass. • P.O. Box 9, Station E, Atlanta, Ga. • 2459 Woodward Ave., Detroit, Mich. • One N. LaSalle St., Chicago, Ill. • 2295 University Ave., Saint Paul, Minn. • 623 Aztec Building, San Antonio 5, Tex. •

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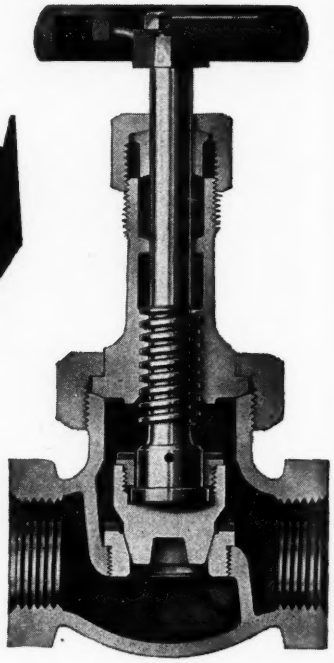
Every feature you want in a

BRONZE GLOBE VALVE

with Plug-Type Disc

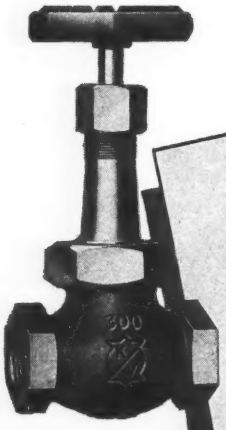
is in the KENNEDY DESIGNS



This Kennedy design brings precision throttling control to the threaded stem type of globe and angle valve. The extra-wide seating surface and the Kennedy Higher-Strength Nickel-Copper Alloy used for both disc and seat ring combine to resist the destructive action of wire drawing and foreign particles; and the disc swivels on the stem to help tight and free seating. Extra assurance of correct seating is provided by matching the renewable seat ring to the disc in each valve.

This Kennedy design is available in a full range of standard sizes for either 200 lb. or 300 lb. steam pressure at 550°F., with corresponding cold water, oil or gas pressures of 400 lb. and 600 lb. They are fully described in the 240-page Kennedy Catalog which shows the entire line of Kennedy iron body and bronze gate, globe, angle and check valves, malleable iron and bronze screwed pipe fittings and cast iron flanged fittings and flanges. Your copy will be sent on request.

Buy From Our Distributor



YOU WANT THESE VALVE FEATURES
. . . you'll find them in this KENNEDY design

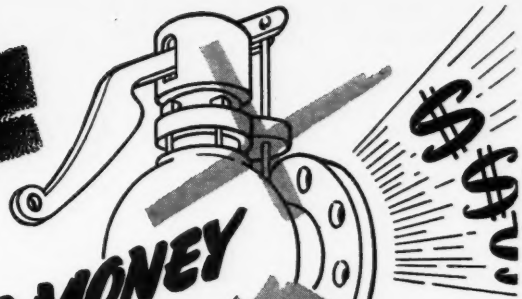
1. **Generous Strength . . .** Body and bonnet are of high-grade dense metal with ample thickness and rounded fillets. Stem has large diameter and extra large number of contact threads.
2. **Easy Operation . . .** Stem and stem contact surfaces are accurately threaded. Deep stuffing boxes permit tightness without undue pressure on packing. Large handwheel gives firm, comfortable grip.
3. **Lasting Tightness . . .** Discs and seats seat accurately, and their sturdy design resists distortion and has special provisions for take-up of wear.
4. **Long Life . . .** Many Kennedy valves have been in daily use a quarter century and more.
5. **Convenient Repacking . . .** Glands and packing are easily accessible.
6. **Economical Maintenance . . .** Long wear built into all parts, and adjustments or other attention are seldom required.

THE KENNEDY VALVE MFG. CO.
Elmira, New York

KV-136

KENNEDY *valves - pipe fittings - fire hydrants*

3,000 psi 1,000°F



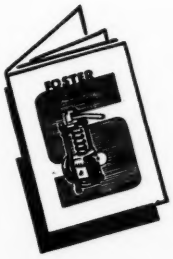
THIS NEW SAFETY VALVE SAVES MONEY ON EVERY POP!

The Foster Type 38-SV Super-Jet Safety Valve for pressures up to 3000 pounds and temperatures up to 1000° F.

Because it reseats as close as 1% below popping pressure, the Foster 38-SV Super-Jet Safety Valve saves steam—saves *money*—on every pop. This new valve blows off only enough steam for safety . . . then reseats positively, without pounding or chatter.

But steam economy is only one advantage of this new safety valve. It is virtually unaffected by changes in temperature—once set under operating conditions, its popping point is constant. It gives full rated nozzle capacity at popping pressure—with negligible accumulation. Full opening is practically instantaneous—reseating is positive, without flutter or rebound even after sustained or successive lifts. And blowdown is adjustable from 8% down to 1% without chatter or pounding because steam cannot accumulate above valve disc.

The Foster 38-SV Safety Valve was especially designed for pressures up to 3000 pounds and temperatures up to 1000° F. In fact, they are now being tested at temperatures considerably above 1000° F. Investigate its many features and advantages by writing for Bulletin 25 today.



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PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

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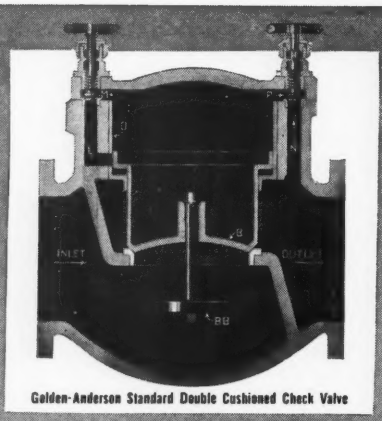
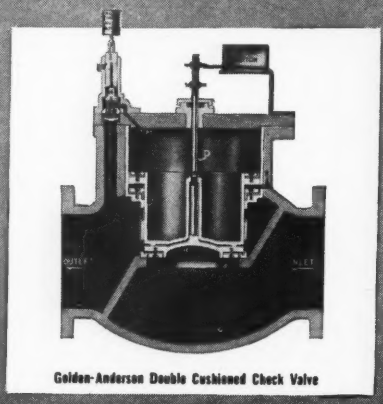
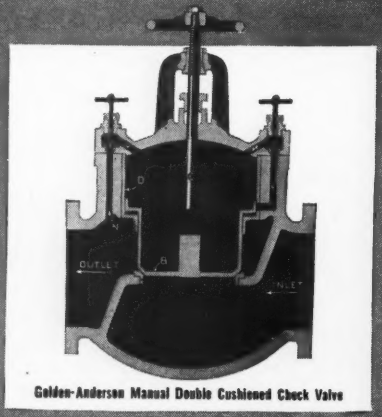


Golden-Anderson Standard Double Cushioned Check Valve



Golden-Anderson Double Cushioned Check Valve

Golden-Anderson Manual Combination Check Valve



Golden-Anderson Manual Double Cushioned Check Valve

THOUSANDS OF SAFE

"STOPS and STARTS"

day after day

hydraulic... automatic... manual

GOLDEN-ANDERSON

CUSHIONED

CHECK VALVES

Designed for safe, dependable control on the most difficult installation to eliminate serious surge and "Water Hammer"—to properly arrest reverse flow. GOLDEN-ANDERSON Cushioned Check Valves are specified on many of the most important new and replacement installations.

Write for informative technical catalog.

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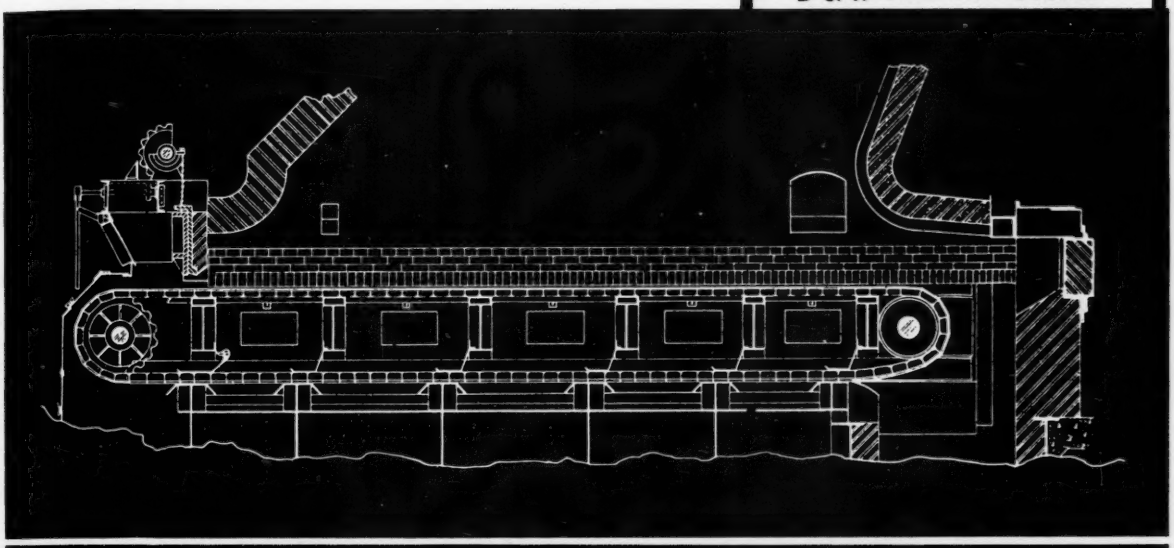
VALVE Specialty Company

KEENAN BUILDING · PITTSBURGH 22, PA.

WALL BRICK DATA

B & W Chain Grate STOKER



Plan to get more Low Cost Steam

This Chain Grate Stoker is designed and constructed by Babcock & Wilcox to perform at top efficiency. Its operation, particularly at maximum demand is materially aided by the installation of CARBOFRAX silicon carbide brick in the clinker zone. More low cost steam with less trouble is obtained.

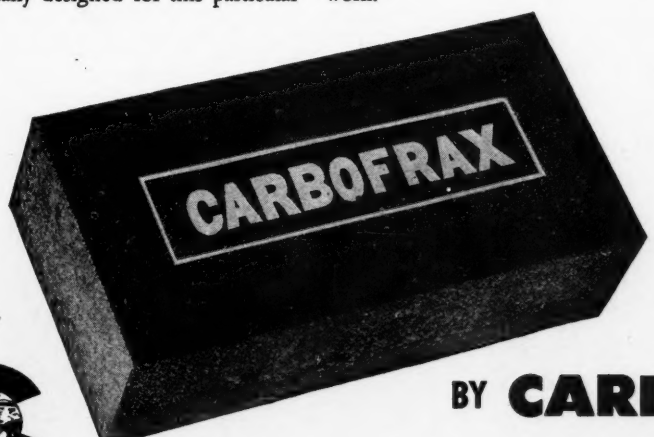
Specifically designed for this particular installation, as shown, the height of the CARBOFRAX lining may be varied to meet conditions encountered.

Increased capacity results because the entire grate area is in use at all times. Clinkers that restrict the fuel bed can not gain a toe hold in the hard dense surface of the CARBOFRAX brick work.

Fuel burns more efficiently. The furnace is on the job longer without repairs. Reports of 8 to 10 years service from a CARBOFRAX lining are not uncommon. Outages because of lining trouble are negligible. This means not only greater output through continuous uninterrupted service, but also much lower cost figures on repairs and maintenance.

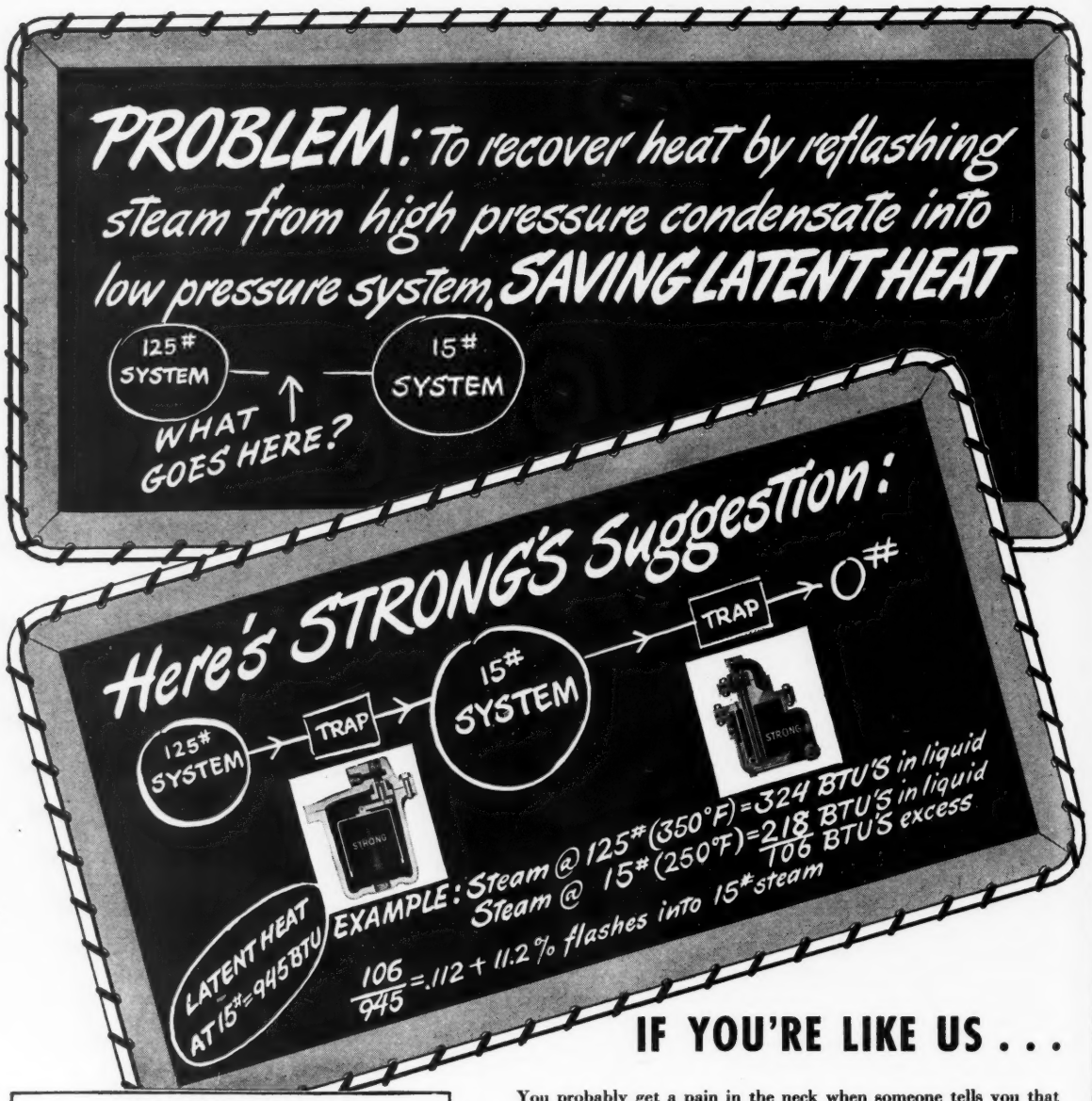
A further reduction in maintenance expense often comes from the longer life of the upper walls. They are well supported at all times by the CARBOFRAX brick which do not cut or burn back.

CARBOFRAX brick provide a proved, practical means of raising the capacity and efficiency of most boiler furnaces. You can get complete engineering data promptly by writing Dept. H-106, The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.



BY **CARBORUNDUM** TRADE MARK

"Carborundum" and "Carbofrax" are registered trademarks which indicate manufacture by The Carborundum Company


PROBLEM: To recover heat by reflashing steam from high pressure condensate into low pressure system, SAVING LATENT HEAT
125# SYSTEM
15# SYSTEM
WHAT GOES HERE?
Here's STRONG'S Suggestion:
125# SYSTEM
TRAP
15# SYSTEM
TRAP
0#
STRONG
LATENT HEAT AT 15#=945 BTU
EXAMPLE: Steam @ 125# (350°F) = 324 BTU'S in liquid
Steam @ 15# (250°F) = 218 BTU'S in liquid
106 BTU'S excess
106/945 = .112 + 11.2% flashes into 15# steam

IF YOU'RE LIKE US . . .

WHAT YOU CAN SAVE

Hi-Press. Condensate per hour	Reflash Steam (11.2%)	SAVINGS Per Hour	Per Day	Per 360 Days
1000 #	112 #	$.045	$1.08	$388.80
2000 #	224 #	.090	2.16	777.60
4000 #	448 #	.180	4.32	1555.20
5000 #	560 #	.225	5.40	1944.00
10000 #	1120 #	.45	10.80	3888.00

(Savings based on steam cost of 40c per 1000 lbs.)

You probably get a pain in the neck when someone tells you that changing from Whosis to Whatsits will save you more than you pay in taxes.

Sure, good equipment can pay its way. And installing the right type shows up the waste caused by using the wrong type.

But real savings grow out of ideas. That's where Strong comes in on steam. With a *complete* line of traps and other specialties, Strong engineers can apply a lot of proved ideas to your installations —and not have to compromise for lack of the right kind of unit to do the best possible job.

Try sending your drainage problems to:

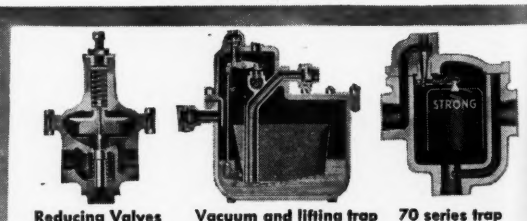
STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio

REG. TRADE MARK

OTHER ANUM-METL Reg. Trade Mark

STRONG

STEAM SPECIALTIES



Reducing Valves | Vacuum and lifting trap | 70 series trap

PALMETTO *Pyramid*

The NEW Molded "Vee" Type Packing Engineers Have Been Looking For

Palmetto Pyramid is an all-purpose molded "Vee" type packing that seals firmly by mere finger-tightening. It is designed according to recently developed and thoroughly proven principles.

Performance of this much-talked-about packing is entirely automatic. Its sealing action is effected by internal pressure. *The greater the internal pressure—the tighter the seal!*

The unique "arrowhead reservoir"—one of the features of Palmetto Pyramid—actually stores and distributes the lubricant. Friction and wear are thereby appreciably reduced; packing and equipment life are substantially lengthened. *And*—look at the heavy wall construction!

Palmetto Pyramid is used for reciprocating as well as rotary motion. It is recommended for all types of hydraulic and pneumatic equipment handling hot or cold water, steam, oil, gasoline and most types of solvents and acids.

"IT PAYS TO KNOW YOUR PALMETTO PACKING DISTRIBUTOR!"

GT-1560

GREENE, TWEED & CO.

Manufacturers of PALMETTO Packings

[illegible] BLVD. AT 238th ST. NEW YORK 66, N. Y.

Plants at New York, N. Y. and North Wales, Pa.

This coupon is for your convenience Mail it today!

GREENE, TWEED & CO.
New York 66, N .Y.

☐ Send descriptive literature covering PALMETTO Pyramid Packings

☐ Send PALMETTO representative to discuss packing

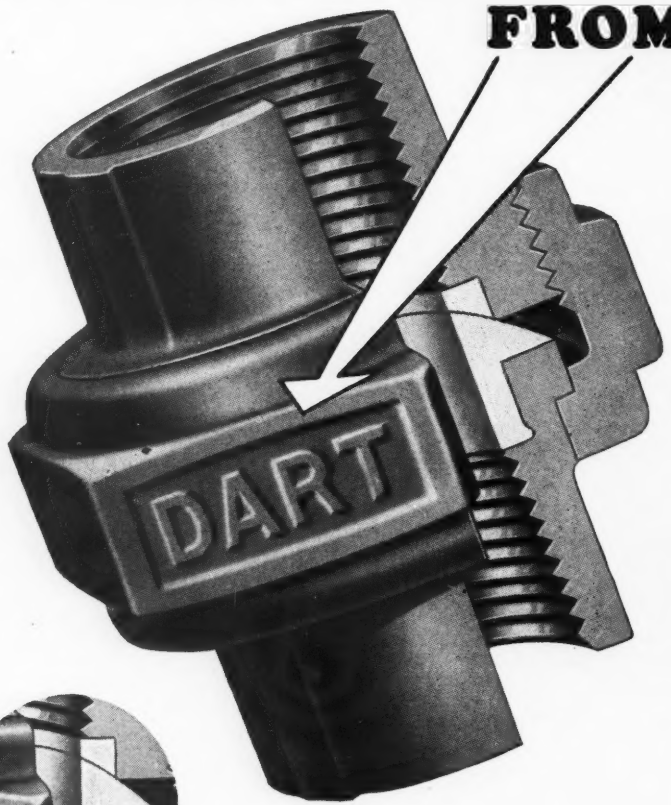
Name .....

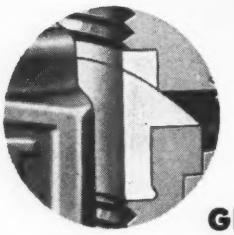
Company .....

Street .....

City ..... *State* .....

YOU GET A Better Deal FROM





THEIR TWO BRONZE SEATS GROUND TO A TRUE BALL JOINT PERMIT THEIR USE OVER AND OVER AGAIN

That's why Darts are cheapest in the long run. Closing and opening easily, they are ready for use in a new location whenever needed. Body and nut are made of high-test air-refined malleable iron—are practically indestructible. Your supplier will be glad to demonstrate the unique Dart construction.

DART UNIONS

E. M. DART. MFG. CO., PROVIDENCE 5, R. I.

MANUFACTURERS' *News*

Chain Belt Buys Ordnance Plant

CHAIN BELT CO. has materially increased its plant capacity through the purchase of the heavy ordnance plant, constructed for the Defense Plant Corp. in West Milwaukee.

The plant, built in 1943, is a large one-story structure with a two-story office bay. It has a frontage of 860 ft. and a depth of 360 ft., giving it an area of about 317,500 sq. ft. Present plans call for its use in the manufacture of chain belts and some construction machinery. Additional office space might be included later.

Patch Is New Hendy Sales Manager

CLIFFORD A. PATCH has been appointed Sales Manager, Western Division of Joshua Hendy Iron Works, succeeding Clarence Jensky, resigned, according to a recent announcement.

Mr. Patch has been successively assistant chief engineer, turbine sales manager, and chief project manager at Hendy. He will supervise sales of all products made at the company's Sunnyvale and Torrance, California, plants — Diesels, turbines, gears, valves and custom built machinery.

Sales of electric motors and generators made at Hendy's Crocker-Wheeler plant, Ampere, N. J., remain under the direction of L. D. Warner.

Leslie Announces Sound Slide Film

A NEW 35-mm. sound-slide film showing methods of handling pressure and temperature control problems, has just been announced by Leslie Co., 257 Grant Avenue Lyndhurst, N. J.

The film (running time about twenty minutes) follows the steam system of a typical industrial plant from the high-pressure steam at the boiler through the power generating equipment, processing machinery, boiler auxiliaries, heating and low pressure steam systems.

Applications and installations of a variety of regulators and controllers are shown by photographs and diagrams. After reviewing general applications, the slide-film analyzes which type of regulator is best for a given purpose.

The complete film story is re-told and illustrated in a handy 24 page booklet which is given each person at the conclusion of the show.

The film is of particular interest to steam, power and process engineers and is available at no cost for meetings of their groups.

Arrangements for showing this slide-film can be made direct through Leslie Co., or through any company agent.

International Nickel Opens Texas Section

THE INTERNATIONAL NICKEL CO., Inc. announces the opening of the Texas Technical Section of its Development and Research Division, which is located in the Bankers Mortgage Building, Houston. It will furnish to industry technical information and assistance relating to alloys con-

The Man in the Field KNOWS when Pre-Fabricated Piping is Right

Men in the field who erect piping know when shop fabrication is well done . . . they know if the sub-assemblies fit correctly, line up easily and have all field welds or flanged joints in accessible positions. When this is the case, the erecting job is easier . . . saves both time and money.

Midwest has a Construction Department which has erected piping of all kinds for 46 years. The critical attitude of this department is the best stimulant to our four pipe-fabricating plants. The Construction Department also frequently contributes useful and practical suggestions for improving pipe fabrication.

This situation has a powerful effect in keeping the whole organization alert . . . and in encouraging continuous improvement. It is one of many reasons why you get the best when you buy Midwest Pre-Fabricated Piping . . . either as materials furnished or piping completely installed.

MIDWEST

CONTRACTING DEPARTMENT *Checks* MIDWEST PIPING QUALITY

MIDWEST PIPING SERVICE IS NATION-WIDE

MIDWEST

PIPING & SUPPLY CO., INC.

MAIN OFFICE: 1450 SOUTH SECOND ST., ST. LOUIS 4, MO.

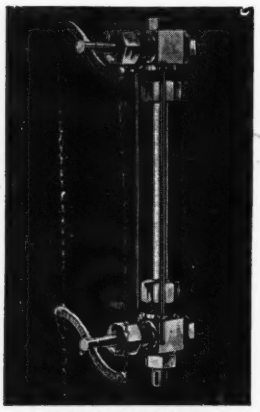
Plants: St. Louis, Passaic, Los Angeles and South Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St.

2266

Precision Made HUYETTE WATER GAUGES

Meet ASME Code . . .

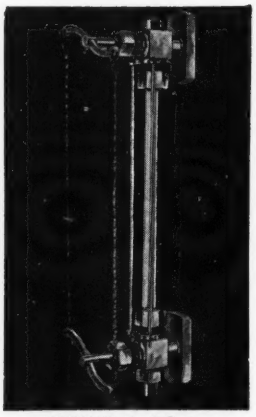
All Huyette water gauges are quick closing . . . well proportioned and made of bronze mixture according to ASME Code . . . and stamped with maximum working pressure. These features assure you of meeting today's demands for equipment that will last long and give 24-hour-a-day service.



"PBH" Vertical Gauge (Screwed connection)

Assure Steam-Proof Service . . .

Because the glass and steam nuts are large to accommodate ample size packings, "PBH" insures steam-proof service. The gauges are opened or shut by less than a quarter-turn—providing quick, efficient shut-off of danger and expense.



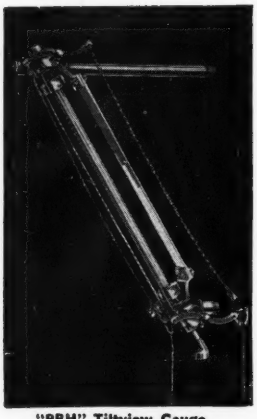
"PBH" Vertical Gauge (Flanged connection)

Give Leak-Tight Service . . .

Leak-tight service is also provided by Huyette Water Gauges. This provides saving and more efficiency. All valves are rigidly tested and inspected before leaving our factory.

Interested?

For complete details and specifications on all "PBH" water gauges, sizes, working pressures and pipe connections, write for Bulletin No. 741. Contains useful charts, tables, photographs. Write today.



"PBH" Tiltview Gauge (Patented)

The PAUL B. HUYETTE COMPANY, INC.

Established 1896

401 N. BROAD ST., PHILADELPHIA 8, PA.

taining nickel. The Section's activities will cover the States of Texas, Oklahoma, Louisiana, Mississippi and the southern half of Arkansas.

R. J. Rice, Metallurgical and Chemical Engineer, will be in charge. Mr. Rice was associated with the Beaumont Iron Works Co. from 1933 to 1938 where he was responsible for the operations of its metallurgical department, melting shop, heat treating department and specifications for steels and irons. Later he became associated with Metal Goods Corp. of Houston, where he held the position of Foundry Engineer and Metallurgist. He directed his activities toward the use of nickel in iron and steel foundries and the industrial application of nickel containing alloys.

G. E. Chemical Department Grows

Further expansion of the General Electric Chemical Department with the formation of a metallurgy division with headquarters here was announced recently.

The new division, representing the third operating unit to be incorporated in the Chemical Department, will handle the sale of various types of permanent magnets and metalurgical products. Principal among these is the permanent magnet material known as alnico, an alloy containing iron, nickel and aluminum as essential ingredients, and generally also cobalt, which alloy is used extensively in motors and generators and which has made possible new designs of precision equipment.

O'Brien Specialty To Represent Warren

Warren Steam Pump Co. Inc., Warren, Mass., announces the appointment of O'Brien Specialty Company, Syracuse, N. Y. as its authorized agent for upper New York State.

William J. O'Brien, president of O'Brien Specialty Co. has been established as manufacturers' representative since 1920. He was District Deputy of National Association of Power Engineers in upper New York State for two years and member of Program and Lectures, Committee of Technology Club of Syracuse.

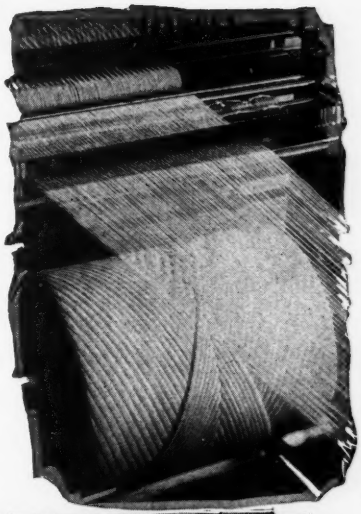
Mr. O'Brien is also a member of National District Heating Association and of Drying and Ventilating Committee, National Technical Association of Pulp and Paper Industry.

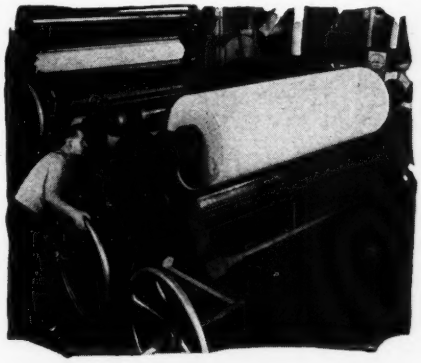
Lyon "Horse-Trades" To Get Steel

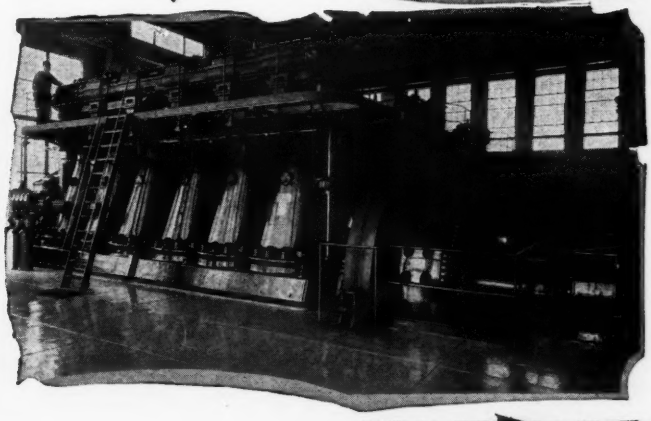
Lyon Metal Products, Aurora, Ill., has tackled the problem of securing hard-to-get sheet steel by going back to an early American custom of "barter and exchange." In a current "horse-trading" campaign Lyon's national advertising and sales force is offering to "swap" finished products for sheet steel.

The appeal to the trade and Lyon's dealers is captioned, "You Furnish the Steel . . . Lyon Will Make the Product." "The Lyon situation," explained H. B. Spackman, Lyon's Executive Vice President and General Sales Manager, "is that our facilities for the production of a wide range of sheet steel products are far in excess of current steel receipts, in spite of the excellent job being done by the steel producers."

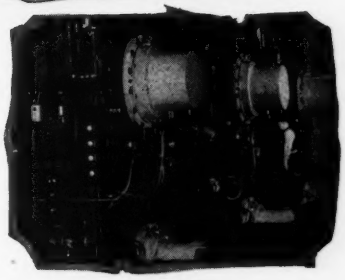
"Lowest Repair Bills in History"







. . . SINCE SWITCHING TO *Tycol* ENGINEERED LUBRICATION



"No sticking valves . . . negligible cylinder wear — with Tycol DIESEL OILS."

"Absence of sludge and corrosion . . . no wear on bearings — with Tycol RIO TURBINE OILS."

"Superior performance under high-temperature service — with Tycol STEAM CYLINDER OIL."

"Complete rust protection . . . corrosion eliminated — with Tycol NO-RUST-OLS."

"Maintenance costs cut 20% . . . since using Tycol E.P. Lubes."

That's how engineers and operating men express their satisfaction with the Tycol Industrial Oils and Greases they are using.

There's a Tycol oil and grease for every industrial need. For complete data on the Tycol lubricant best suited for your needs, get in touch with your nearest Tide Water Associated office today.

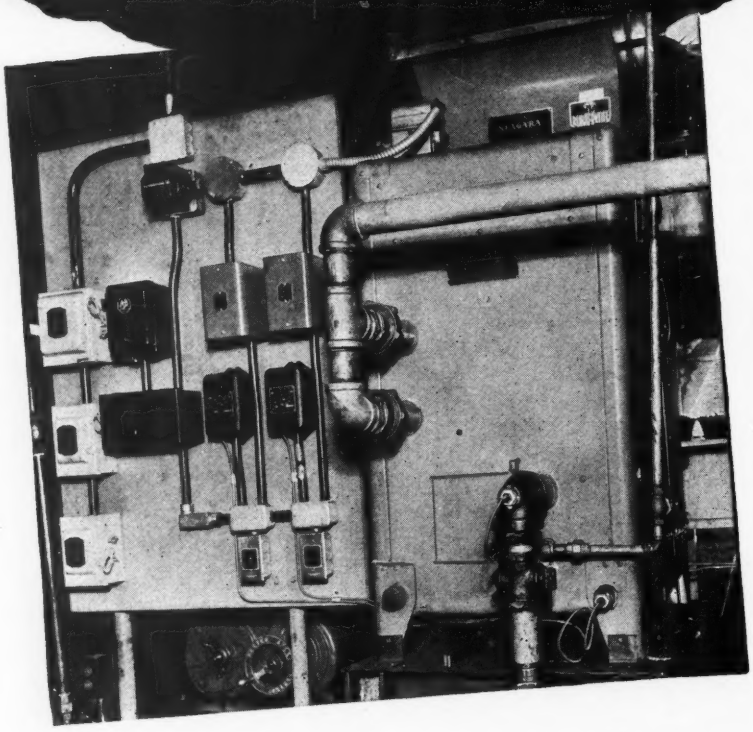
LUBRICATION—"ENGINEERED TO FIT THE JOB"

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE • NEW YORK 4, N. Y.

LET *Air* DO THE WORK OF COOLING



● The **NIAGARA AERO HEAT EXCHANGER** makes the atmospheric air take up the heat you want to remove from power equipment or industrial process. It is done by the evaporation of a small amount of water, removing 1000 BTU for every pound of water evaporated. With this method it is also easy to control temperatures closely . . . to assure accuracy in process results . . . speeding up production at lower cost.

Well designed and built to last, **NIAGARA AERO HEAT EXCHANGERS** have made an excellent record for reliability in service and freedom from maintenance trouble and expense.

Ask for Bulletin No. 96-PP.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

405 Lexington Ave. New York 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING • HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Combustion Organizes Mexican Subsidiary

COMBUSTION ENGINEERING CO., INC., New York, announces the formation of a new company to meet the needs of Mexican expansion programs in the public utility, manufacturing and mining industries for additional steam generating facilities. The new company, Combustion Engineering de Mexico, S. A. is located at Lopez 1, Mexico, D. F., and is organized to provide sales, technical and installation services in connection with Combustion's full line of boilers, fuel burning and related equipment. Resident executives of the new company are George C. Siefert, Vice President and General Manager, and Seldon Morrill, Manager of Installation and Service.

Hewitt's New Distributor

HEWITT RUBBER, Buffalo, division of Hewitt-Robins Inc., has announced the appointment of Monarch Rubber & Supply, Inc. as a new distributor of its "Job-Engineered" industrial rubber products. Offices and warehouse of the new concern serving the San Francisco-Oakland areas are at 546 Howard Street, where the company maintains a complete factory stock of industrial hose, belting and packing. At the head of the new company are Larry J. Burmester and J. J. Foutz. Both of these men are factory-trained and have served more than 10 years in the industrial rubber product sales and service field. Burmester is a former Hewitt branch manager.

B&W's 2,000,000-V X-Ray For Weld Study

A 2,000,000-v X-ray machine will be installed by The Babcock & Wilcox Co. at Barberton, Ohio, this fall. Purchase of this machine was arranged for during the war. It will be the first use of a machine this size for the purpose of examining welds in pressure vessels. The cost of the equipment, together with a special building to be erected, and the installation, will be $150,000.

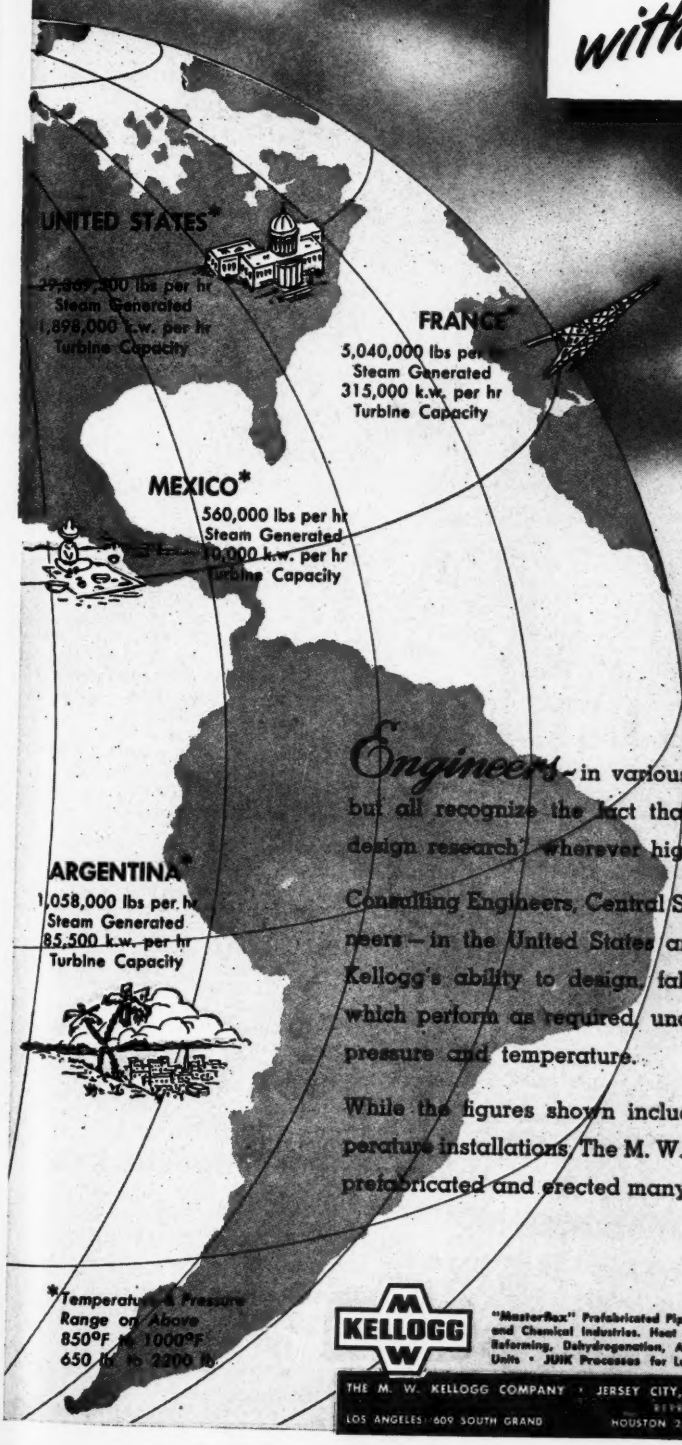
By this purchase, The Babcock & Wilcox Co., will substantially increase the equipment used at the Barberton plant for the examination of pressure vessel welds, raising to 12 the number of X-ray machines used there. Pioneers in the application of X-ray to search for flaws in pressure vessel welds, the company explores every inch of main welds in such vessels. This examination is but one of the many precautions taken to assure safe and sound process equipment. X-ray makes such 100 per cent examination feasible.

Ground has been broken for a special building to house the new machine. It will be erected adjacent to the location of the present 1,000,000-v X-ray unit. The building has been designed to protect personnel from radiation and to make possible examination of the largest size drums made by the company.

Rockwell Adds Hydraulics Division

A NEW HYDRAULICS DIVISION, to specialize on the development of hydraulic equipment, has been established by the Rockwell Manufacturing Co., Pittsburgh. W. H. Marsh will be general manager of the division. Mr. Marsh joined the Pittsburgh Equitable Meter Division of Rockwell in 1934 after previous experience with the Pittsburgh Coal. Co., Gulf Refining Co., John F. Casey and the Pennsylvania Pump Co.

HERE and THERE with KELLOGG



Engineers—in various countries—speak different languages, but all recognize the fact that "there is no substitute for scientific design research" wherever high pressure piping is to be installed.

Consulting Engineers, Central Station and Industrial Power Plant Engineers—in the United States and abroad—know they can rely on Kellogg's ability to design, fabricate and erect piping installations, which perform as required, under the most advanced techniques of pressure and temperature.

While the figures shown include only high pressure and high temperature installations, The M. W. Kellogg Company has also designed, prefabricated and erected many piping jobs for lower pressures.

KELLOGG

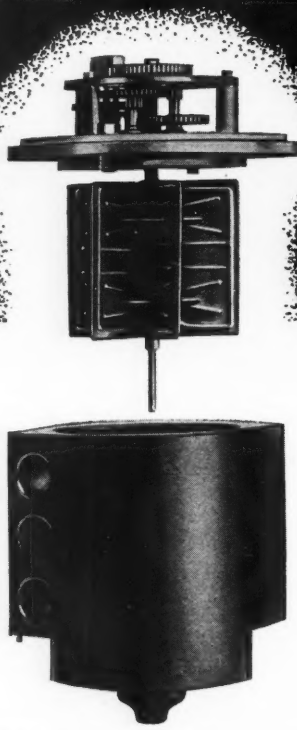
"MasterFlex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

THE M. W. KELLOGG COMPANY • JERSEY CITY, NEW JERSEY • 225 BROADWAY, NEW YORK 7, N. Y.

REPRESENTATIVES

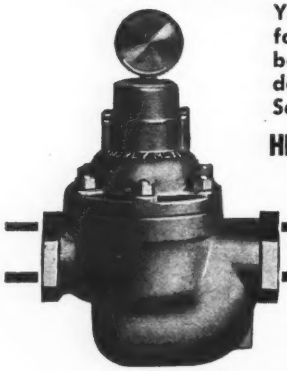
LOS ANGELES: 609 SOUTH GRAND — HOUSTON 2, TEXAS: 402 ESPERSON BLDG. — TULSA: PHILTOWER BLDG.

BUILT TO TAKE PUNISHMENT



HENSZEY *Feed Water* METERS

Notice the simplified, rugged construction of the inside mechanism of the Henszey Meter. The rotor (directly connected to the gear train) fits into the measuring chamber without close clearances. Bearing surfaces, shafts and bushings subject to friction and hard wear are made of tough, long-wearing Stellite. Calibrations of the straight-reading horizontal register can be made to read in gallons, pounds, or cubic feet at any specified temperature.



Yes, that's why Henszey Meters are used for dependable, accurate measurement of boiler feed water, boiler blowdown, condensate, chemicals and other similar liquids. Send for bulletin.

HENSZEY CO. Dept. C10, Watertown, Wis.

HENSZEY

FEED WATER METERS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Flow Indicators • Boiler Feed Regulators • Proportioning Valves
also MILK EVAPORATORS and PRE-HEATERS

MANUFACTURERS' *Personals*

Andriola To Head De Laval Research

TO HEAD ITS recently announced engineering research program, the De Laval Steam Turbine Co., Trenton, N. J. has announced the appointment of A. D. Andriola as Chief Research Engineer.

Mr. Andriola, who since 1941 was Assistant to the Vice President in charge of Engineering of the Cramp Shipbuilding Co., will work directly with C. R. Waller, Vice President in charge of De Laval Engineering. A member of the ASME and the Society of Naval Architects, Mr. Andriola graduated from the Webb Institute of Naval Architecture and Marine Engineering and the University of Michigan and took special courses at Columbia University and the Massachusetts Institute of Technology.

The new engineering research program which Mr. Andriola heads is chiefly identified with the development of turbines, compressors, pumps and marine and aircraft units.

Kalinske Heads Infilco Hydraulics

ANNOUNCEMENT HAS just been made by Infilco, Inc., of the appointment of A. A. Kalinske to the post of Chief Hydraulic Engineer. To this position Mr. Kalinske brings a background of highly specialized experience covering nine years of university teaching, research and outside consultation.

During his years at the University of Iowa, Mr. Kalinske filled the positions of Associate Professor and Associate Director of the Institute of Hydraulic Research, U. of I. His work ranged from hydraulic testing to fundamental research in hydrodynamics. But he also found time for many activities outside of his regular duties. During the summers of 1941 and 1942 he did special consulting work for the U.S. Navy, in Washington, on fluid mechanics problems. He is a member of the American Standards Association Committee, and has been largely responsible for many of the provisions of a National Plumbing Code now being completed by that group. Kalinske is also the author of some fifty technical papers published in scientific journals. The organizations in which he now holds membership include the American Society of Civil Engineers and the Society for Promotion of Engineering Education.

Pollard Is Elliott Engineering Manager

E. I. POLLARD has been appointed engineering manager of Elliott Co. Ridgway Division according to a recent announcement.

With an extensive background in the design of electrical equipment such as large water-wheel generators, synchronous condensers and turbo-generators, Mr. Pollard has centered his efforts the last year in the design of a complete new line of Elliott motors and generators.

Mr. Pollard is in charge of electrical en-

ANOTHER WILSON FIRST

NOW YOU CAN CLEAN TUBES AS SMALL AS ¼" I. D.

New Wilson Pistol Grip Provides Complete, Instantaneous One-Hand Control of Speed and Power.

Once again our engineers have developed a simple solution to a very specialized tube cleaning problem. With the Wilson Pistol Grip Tube Cleaner they've proved that even tubes as small as ¼" I.D. can be cleaned easily, effectively, economically.

The Pistol Grip weighs only 3 pounds — no more than a 12" stilson wrench. It provides the operator with one-hand control for cleaning small, straight tubes of ¼" to 1" I.D. in sterilizers, hot water heating units, lube oil heaters, oil pre-heaters, heat exchangers and other small bore tube apparatus.

Like the well-known Wilson Trigger Power, Pistol Grip has these exclusive operating features:

1. Higher torque at any speed than any other tube cleaner in its class. This cuts down-time radically and means production dollars saved.
2. Unusually fast action (up to 3500 rpm working speed) permits the use of standard Wilson cleaning accessories.
3. Scavenging agent is carried down the hollow shaft to the cutter-bit . . . even coal oil can be used when it is economically available.
4. Special Rotary Seal at front end prevents leakage of scavenging agent and eliminates stuffing box and packing troubles.
5. Even sagged tubes can be cleaned with Pistol Grip. The hollow shafting has sufficient "give" to follow the contour of the sag without damaging tube walls.
6. Pistol Grip provides the operator with instantaneous one-hand control of speed and power.

Actual photo showing trigger control

These features are your assurance that you will get the kind of tube cleaning you want — the kind you need for full economy and long tube life.

Wilson Pistol Grip tube cleaners are now available from stock. For additional information, please address department N.

TW-718

THOMAS C. WILSON, INC.
21-11 44th Avenue, Long Island City 1, N. Y.

WILSON
TUBE CLEANERS

AND NOW FISHER BUTTERFLY VALVE

DESIGNED ESPECIALLY FOR DIAPHRAGM MOTOR OPERATION

Features

1. High pressure cast steel body with air fins for high temperature, high pressure operation.
2. Aerodynamic designed flapper to reduce torsional forces to a minimum.
3. Flapper bolted to squared portion of rotary shaft.
4. Large powerful diaphragm operator with heavy duty large springs.
5. Rotary shaft equipped with roller bearings or with stellite faced bearings, with thrust bearing to counteract stem unbalance.
6. Cable drive features straight line motion from diaphragm to flapper, eliminates errors of angularity and lost motion.

7. Travel indicator mounted on housing to show position of valve.
8. Operator and drive mechanism mounted in weather-proof housing.

MATERIAL AND SIZES...

Electric cast steel body, sizes 8", 10", 12" and 16"

FISHER GOVERNOR COMPANY 1034 FISHER BUILDING MARSHALLTOWN • IOWA

gineering for the company replacing Quintin Graham who recently has been appointed assistant manager of the Ridgeway Division.

Newquist V.P. of Roots-Connersville

RALPH R. NEWQUIST has been elected Vice President in Charge of Sales of Roots-Connersville Blower Corp., Connersville, Ind., one of the Dresser Industries.

A native of Youngwood, Pa., and a graduate of Pennsylvania State College, Mr. Newquist has been successively employed by the Reliance Electric & Engineering Co., The St. Louis Co., and Allis-Chalmers Mfg. Co.

He is a member of AIEE, the Society of Naval Engineers, and the American Society of Naval Architecture and Marine Engineering.

Bowser Names Chapman C.E., Industrial Pumps

E. W. CHAPMAN has been appointed Chief Engineer of the newly created Industrial Pump Division of Bowser, Inc., with headquarters in Fort Wayne, Ind., according to a recent announcement.

Mr. Chapman was formerly Chief Engineer of Blackmer Pump Co., Grand Rapids, Mich., and has been active in the pump industry for the past 15 years. He is considered an authority on rotary pump design and is the author of many technical articles and monographs on liquid-handling problems.

New Officers of Rust Engineering

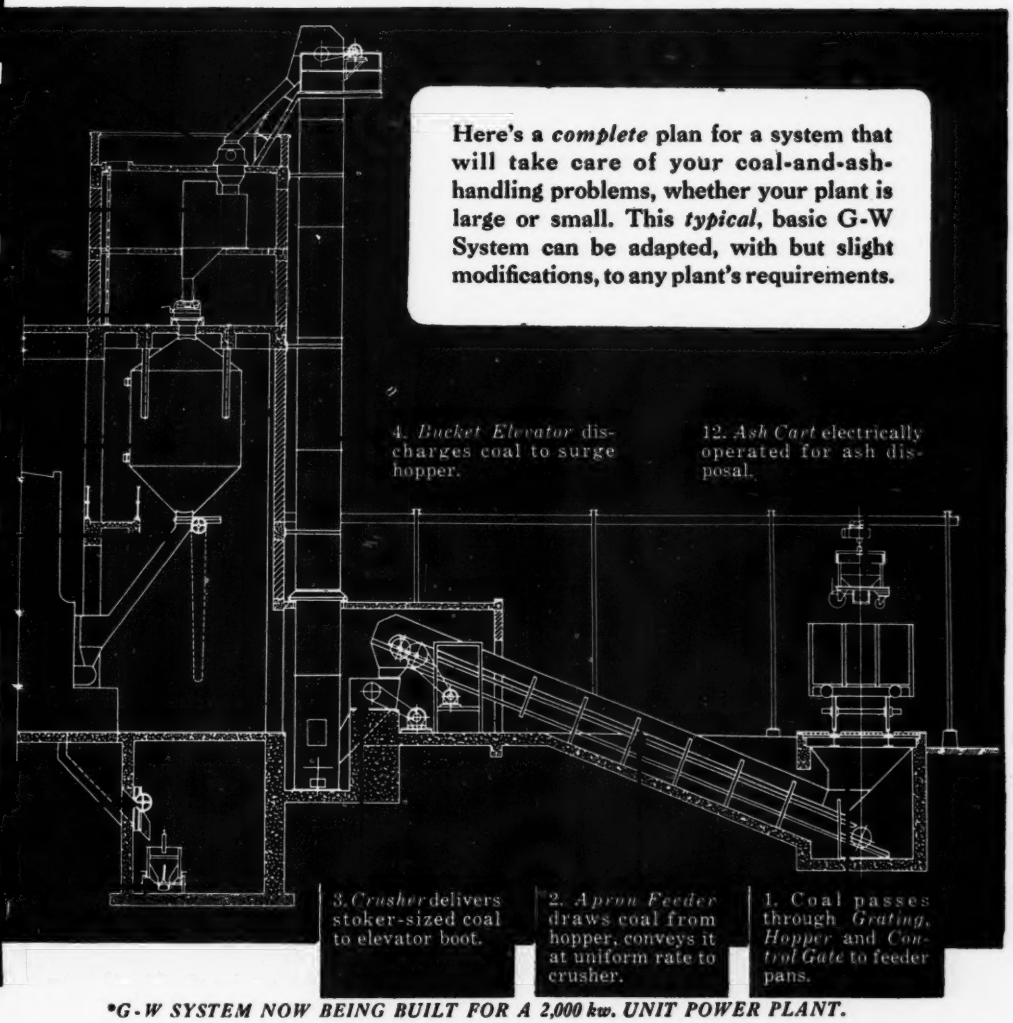
R. L. HESS, JR., has been named secretary of The Rust Engineering Co., Pittsburgh, Pa., and will also direct the activities of the legal department. Mr. Hess, who had been serving as assistant secretary and assistant treasurer of the company, succeeds the late Ralph B. Baldridge in his new position. Dickson C. Shaw, III, an attorney in the legal department, will take Mr. Hess' position as assistant secretary.

Fisher Governor Co. has announced that T. B. "Sam" Burris has been appointed assistant sales manager, Process Controls Division. He will devote most of his time and effort to that portion of Fisher Governor Co. business dealing with the process industries—that is, refineries, chemical plants and process engineering contractors.

American Engineering Co., Philadelphia, announces the appointment of Paul J. Stein as its sales representative for Taylor and AE Perfect Spread Stokers for the territories including the western portion of Pennsylvania, the eastern counties of Ohio, and northern West Virginia. Mr. Stein was associated with Babcock and Wilcox for a number of years and more recently with the Koppers Coal Division of the Eastern Gas and Fuel Associates. He has had considerable experience in power plant work and is exceptionally well qualified to serve the needs of power plants on industrial stokers.

Chicago-Wilcox Manufacturing Co., manufacturers of gaskets, has announced the appointment of Erle J. Zoll as president of the organization. Mr. Zoll has been associated with Chicago-Wilcox for the past twenty-nine years handling sales.

This *one* basic blueprint* solves *all* problems in coal-and-ash-handling


5. Surge Hopper Control Unit assures constant supply to scale.
6. Scale automatically weighs, records and discharges to shuttle belt conveyor.
7. Shuttle Belt Conveyor serves several bins from central weighing point.
8. Storage Bins have coal level control.
9. Control Gate and Spout to stoker.
10. Ash Unloading Gate.
11. Ash Cart manually operated through tunnel.
Here's a complete plan for a system that will take care of your coal-and-ash-handling problems, whether your plant is large or small. This typical, basic G-W System can be adapted, with but slight modifications, to any plant's requirements.
4. Bucket Elevator discharges coal to surge hopper.
12. Ash Cart electrically operated for ash disposal.
3. Crusher delivers stoker-sized coal to elevator boot.
2. Apron Feeder draws coal from hopper, conveys it at uniform rate to crusher.
1. Coal passes through Grating, Hopper and Control Gate to feeder pans.

*G-W SYSTEM NOW BEING BUILT FOR A 2,000 kw. UNIT POWER PLANT.

COAL IN... ASHES OUT

HANDLING HEADQUARTERS
for Industrial Conveying and Elevating Equipment . . . for Infra-Red Baking and Drying Equipment . . . for Ice Handling Tools and Ice Processing Machines.

G-W will do the complete job. From start to finish G-W shoulders full responsibility for all details of design, manufacture, and erection. You save the time and money usually spent in dealing with sub-contractors. Two-way assurance that G-W will install the coal-and-ash-handling equipment that's best for your plant: hundreds of satisfied G-W equipment users; more than 130 years' experience in designing material-handling equipment for all types of industries. Gifford-Wood Co., 420 Lexington Ave., New York 17, N. Y.; 565 W. Washington St., Chicago 6, Ill.—Factory: Hudson, N. Y.

G-W HANDLES IT...
faster • easier • cheaper

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SINCE 1814

Four Reasons for All-Out Popularity of

SONDERGLASS

More highly resistant to pressure and temperature strains
Easier to see—Safer to use
Resists clouding and corrosion
Gives notably long low-cost service
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Order from your steam supply man or directly from us today and get the *best* in gauge glasses

A. W. CHESTERTON CO.
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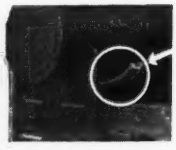
Distributors in Principal Cities

"Boiler Repairs Reduced 75%"
writes user of **NATIONAL GIRTH SEAM PROTECTOR**



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

In this capacity he is well known throughout the plumbing and heating, refrigeration, power and oil industries. In addition to his new duties as president, he will continue to be in charge of sales for the company.

Arthur C. Wilby has been elected vice president of United States Steel Co. of Delaware, it was announced recently. Mr. Wilby, who has been associated with United States Steel since January 9, 1909, will maintain his headquarters in Chicago.

Arnold Pfau, last of the three original engineers who participated in 1904 in the initial organization of the hydraulic department of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., has retired after 42 years with the concern, according to a recent announcement. Consulting engineer of the firm's hydraulic department for many years, Mr. Pfau is retiring from Allis-Chalmers at the age of 72.

Willard M. Broxham has been named manager of sales for the fabricated plate division of the Graver Tank & Mfg. Co., Inc. He formerly managed the concern's Philadelphia office and now makes his headquarters at the general offices in East Chicago, Ind.

Irwin McNiece has been named assistant district superintendent of service and erection for the Los Angeles district of the Allis-Chalmers Mfg. Co., Milwaukee, Wis., according to a recent announcement. A graduate of Princeton University, McNiece joined Allis-Chalmers in 1912, coming from the old Telluride Power Co., Utah. He worked in Allis-Chalmers' service and erection department and as a special representative for the company's hydraulic department out of Salt Lake City before entering World War I as a lieutenant in the engineering corps. During the last three and one-half years he has been working on Allis-Chalmers marine programs in Seattle, Tacoma and Portland shipyards.

Liquid Conditioning Corp. has announced the election of the following officers: S. B. Applebaum, president; H. L. Tiger, vice president and treasurer; Norman L. Brice, secretary and chief engineer; S. S. Sulzycki, assistant secretary and controller.

United States Steel Corp. recently announced the election of John E. Goble as president of National Tube Co. Mr. Goble succeeds Charles R. Cox, who has become president of Carnegie-Illinois Steel Corp., another U. S. Steel subsidiary. Serving as sales vice-president of National Tube Co. since Jan. 1, 1936, Mr. Goble has been with U. S. Steel and companies now affiliated with U. S. Steel for 21 years.

Harold C. Conners and Harold R. Fosnot have been named by the Graver Tank and Manufacturing Co. to head the firm's Chicago area sales activities. Both war veterans, Mr. Conners will handle steel plate sales while Mr. Fosnot will represent the Graver Process Equipment Division, specializing in water conditioning equipment.

W. Stuart Johnson has joined the A. O. Smith Corp. as manager of hydraulic products sales in the Pacific coast district. He will make his headquarters in the Los Angeles office of the company. Mr. Johnson previously was with Southern California Edison, Inc., as engineer in charge of pumping equipment. He was a major in the war, serving as a production engineering officer with the air technical service command. Prior to his war service, he was associated with the Byron Jackson Co. and Ingersoll-Rand Co.

ENGINEERING PROGRESS REPORT # 4

LJUNGSTROM AIR PREHEATER

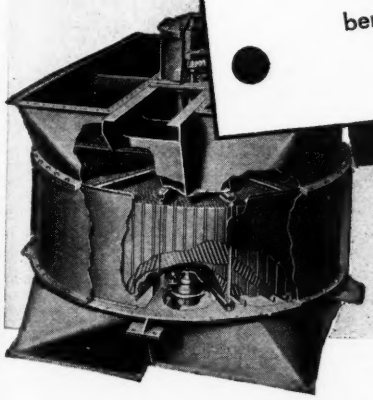
Trend to High Heat Recovery Stimulated by Preheater Progress

In modern boiler plants, high-temperature preheated combustion air is a subject of ever-increasing importance.

Among the benefits of improved combustion with preheated air are:

1. Improved ignition rate and stabilized flame.
2. Increased furnace capacity.
3. Low exit gas temperatures result in greater fuel savings.
4. Proper mill drying of the coal with pulverized coal firing.

The Ljungstrom air preheater maintains a uniform heat recovery performance. It makes possible maximum recovery and highest air temperatures, thereby maintaining all the benefits of high temperature preheated air.



THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, N. Y.

Why B-H No. 1 Insulating Cement IS IDEAL FOR MAINTENANCE JOBS

IT'S RUST INHIBITING

Because B-H No. 1 Cement contains a rust inhibitor which prevents corrosion of metal surfaces, it is excellent for use on flanges, valves, and other fittings. Even if used on cold, slow drying surfaces it forms a firm, rust-free bond.

IT'S EASY TO APPLY

Just mix B-H No. 1 Cement to a trowelable consistency and apply. It sticks, even to smooth surfaces—makes covering of under surfaces and pipes easy, even for unskilled workmen.

IT'S EFFICIENT

The exceptional efficiency of B-H No. 1 Insulating Cement is due to the high temperature resistant *black* rockwool from which it is made. The dead air cells in the nodules of rockwool provide maximum insulating efficiency and lightness in weight. B-H No. 1 Insulating Cement dries without cracking—withstands temperatures of 1800°F.—and is reclaimable if temperatures have not exceeded 1200°F.

IT'S CONVENIENT

Packed in convenient sized multiwall paper bags containing 50 lbs. Ready for instant use. There is no loss or breakage as with molded types of insulation.

The coupon below will bring you full information and a practical sample of B-H No. 1 Insulating Cement.

Baldwin-Hill

SPECIALISTS IN THERMAL INSULATION PRODUCTS

Baldwin-Hill Co., 515 Breunig Ave., Trenton 2, N. J.

Send information on products checked below

☐ Free sample of B-H No. 1 Cement

☐ No. 100 Pipe Covering—effective up to 1200°F. (for long runs overhead, underground, Diesel exhausts).

☐ Mono-Block—the one-block insulation for all temperatures up to 1700°F.

☐ Black Rockwool Blankets (felted between various types of metal fabrics).

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International Control of Atomic Energy

(*Continued from page 126*)

to be sure, be captured. They may be surreptitiously mined. If they are, and the violation is not caught at that stage, then you have another safeguard in the second step,—that only the authority can process those materials. So you have a second chance to catch violators. Then, of course, there is the third step.

Danger in Making Concessions

One of the most dangerous things in the world, obviously, would be to start with a plan like this and in the course of negotiations make concessions that would weaken the safeguards at any point. If that were done, it would be far better that this plan had never been thought of. This particular plan is one that rests on the maintenance of all its interlocking safeguards.

Whether or not it is accepted is not the concern of the board of consultants or the Committee. The Committee did what the Secretary of State asked it to do, was to get a study completed and lay it before those who have the responsibility for policy. There is one more thing that has been done; that is to direct attention to the realities of this problem and away from the loose talk which was going on before. There was a lot of talk before that seemed to be based on the assumption that the pre-eminence of the United States in this field rests on certain secrets that were locked up in General Groves' desk.

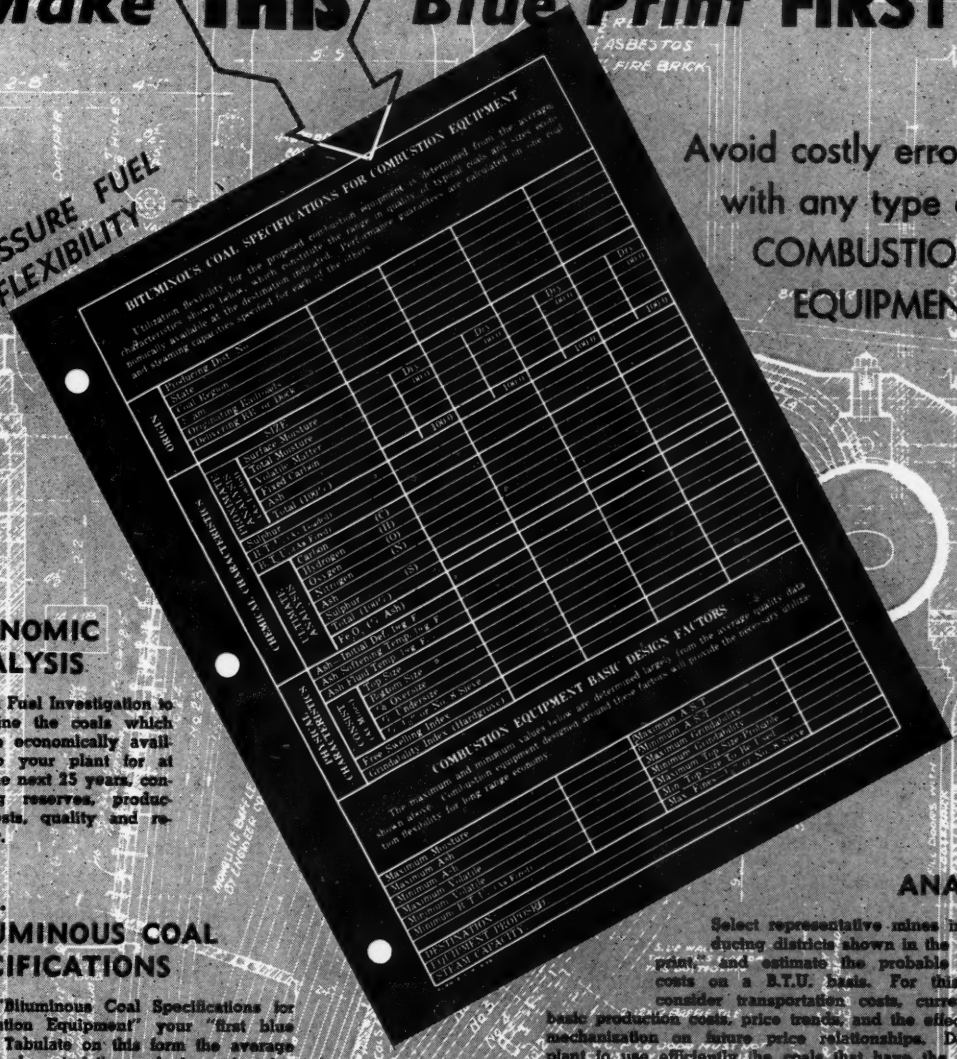
Reason for Our Pre-eminence Not Locked in General Groves' Desk

That is not the situation at all. A debate on that basis is futile and ill-informed. The American pre-eminence in this field has a much more solid foundation than that. Of course, one part of the foundation is based on the fact that this country is in the forefront of scientific knowledge. But it isn't going to be in the forefront very long. Any scientist who proceeds from the past into the future must reach the same discoveries. American pre-eminence rests on something more solid than that, and that is that there is a tremendous wealth of technological knowledge in this country. We know how to take laboratory problems and put them into factories stretching over dozens of square miles. We have the industrial civilization here which can take those technological blueprints and translate them into action. We have access to the raw materials. These are the solid bases of American pre-eminence, not merely the fact that we know something other people don't know.

Make THIS Blue Print FIRST

ASSURE FUEL FLEXIBILITY

Avoid costly errors with any type of COMBUSTION EQUIPMENT



1St. ECONOMIC ANALYSIS

Make a Fuel Investigation to determine the coals which will be economically available to your plant for at least the next 25 years, considering reserves, production costs, quality and reliability.

2ND. BITUMINOUS COAL SPECIFICATIONS

Make "Bituminous Coal Specifications for Combustion Equipment" your "first blue print." Tabulate on this form the average quality, characteristics and sizes of at least four coals from different producing districts. These coals should constitute the range of coals to be used for generating low cost steam during the life of the plant.

From these average data establish the Combustion Equipment Design Factors, using sufficient tolerances to cover normal variations in quality. It is a costly error to purchase new equipment which is inadequate to burn the range of coals economically available.

3RD. COAL ANALYSIS

Select representative mines in the producing districts shown in the "first blue print," and estimate the probable delivered costs on a B.T.U. basis. For this purpose consider transportation costs, current prices, basic production costs, price trends, and the effect of mine mechanization on future price relationships. Design the plant to use efficiently the coals that have the best competitive future.

FAIRMONT LOW FUSION COAL MEETS EVERY REQUIREMENT FOR LOW COST STEAM GENERATION

. . . it can be burned economically in any equipment properly engineered for its use . . . huge reserves extend the availability of this coal into the far distant future. . . . it usually represents "the best value for the fuel dollar" for long range planning . . . engineering to use FAIRMONT COAL assures the lowest overall steam cost for the life of the plant.

MAIL COUPON

FAIRMONT COAL BUREAU, Chanin Bldg., 122 E. 42nd St., New York 17, N. Y.

1. Return this coupon for a copy of the form "Bituminous Coal Specifications for Combustion Equipment."
2. Place my name on the mailing list for Fairmont Coal Bureau Reference Bulletins. 1. ☐ 2. ☐ (Indicate desires by checking squares.)

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PPE 10-46

ADSCO
Expansion
Joints
• ADSCO exclusive features have been proved and approved above ground and under ground in thousands of installations handling high-pressures and temperatures. ADSCO design provides for accurate, free movement of the slip. Alignment is maintained and binding on the packing is eliminated.
ADSCO Piston-Ring Type Expansion Joints illustrated above permit adding packing when joint is under full operating pressure without shutting down the system. Piston-rings at inner end of the slip hold back pressure during repacking. Write for Bulletin 35-15E.
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA, N.Y.
MAKERS OF UP-TO-DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

NEW ENGINEERING BOOKS

Simplified Architectural Drawing, by T. C. Buss, Jr.; first editon, 258 pages, illustrated, size 8½ by 11 in., cloth binding. Price $4.75.

Architectural Drawing and Detailing, by J. Ralph Dalzell and James McKinney; first edition, 212 pages, illustrated, size 6 by 8½ in., cloth. Price $2.50. Both published by The American Technical Society, 58th and Drexel Avenue, Chicago, Ill.

These two very practical books, in this writer's opinion, maintain the high standards of the above publishing organization for practicality and usefulness. Like all their other books, these two also are designed to meet the everyday, down-to-earth problems of anybody who must make architectural drawings. Since many engineers become involved in these problems in the course of industrial construction activities, they can get much valuable help for themselves and their subordinates from either or both of these books.

The book by Mr. Buss, a registered architect in the state of Illinois, and head of the Department of Architectural Drawing at the Pullman Free School of Manual Training, contains possibly more information on industrial and commercial building architecture than the other. It begins with a good discussion of drafting equipment and how to use it, lettering and graphic procedures and problems. One interesting feature is a brief chapter on the history of architecture. This is followed by a chapter on working drawings and construction of various types of buildings, types of sketching and detailed instructions for drawing architectural plans. Types of construction including masonry veneer, ordinary masonry, mill construction, steel frame construction and the like are well explained and illustrated. There is a good chapter on the engineering calculations involved in footings, beams, and other structural members. Another good feature of the book is a fine chapter on specifications, contracts and estimating. Display drawings and the various types of architectural rendering are well treated and the book closes with a long list of practical problems to be worked out.

The book on Architectural Drawing and Detailing by Messrs. Dalzell and McKinney, places more emphasis on strictly domestic construction. It too begins with good discussions of architectural drawing including lettering, drawing technique, weights of lines and so on, and then shows specifications, typical detailing and similar details of domestic construction. There is a good chapter on rendering in pen and ink and one on landscaping.

Turbines, Condensers and Feedwater Heaters 1943-1944, Publication No. L3; 64 pages, paper bound, size 8½ by 11 in., illustrated; A Report by the Turbines and Condensers Subcommittee of the Prime Movers Committee, Edison Electric Institute, 420 Lexington Avenue, New York. Price $1.00 to members, $2.50 non-members and $2.60 foreign countries.

One of the major subjects considered in this report is a review of turbine specifications. There seems to be some general agreement that existing standard contract clauses were fairly satisfactory, since disagreements between manufacturers and purchasers are apparently settled without undue difficulty. A review of the ASME Committee's Report on Standardization of Steam Turbines is given.

Reports from operating companies on performance of turbine generator units, cover mostly the fouling of turbine blading by deposits from steam carry-over.

Turbine manufacturers present comments on the problems involved in design and operation of their equipment and show illustrations of new developments.

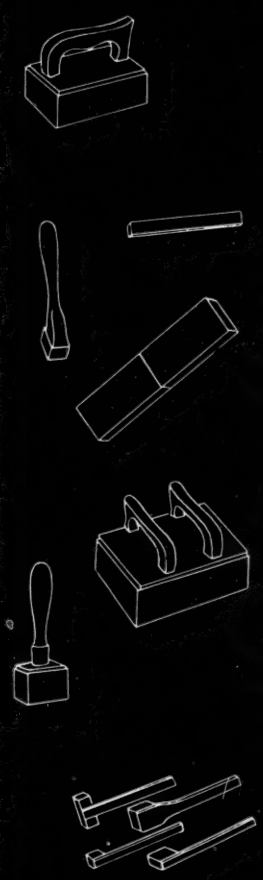
There has been little change in the design of new condensers in the past two years, even though the large number of purchasers would ordinarily bring out innovations. The major problems cited by operating companies were in tube vibration, extension of tube life and cleaning condensers with acid. Factors apparently helping to minimize tube vibration are discussed in some detail. Several statements on acid cleaning of condensers indicate that it is becoming an important factor and five manufacturers' statements are included; one giving considerable data on tube vibration.

Section III of the report, discussing feed water heaters, also shows that cleaning of feed water heaters by chemical means is becoming increasingly popular.

(*Continued on page 174*)

KEEP MOTORS IN CONDITION TO RUN AT RATED CAPACITY

with IDEAL Resurfacers



It is easy to restore and maintain the rated capacity of your motors and generators with **IDEAL** Commutator Resurfacers—stop sparking, eliminate pits, burns and rough spots.

Quick! No dismantling, no reassembling. Job may be done outside of work hours. No production delays.

Easy! Resurfacers are applied by hand and smooth commutator or slip ring while the motor turns under its own power. One man does the job.

Better! Resurfacing is done while armature is running in its own bearings, thus compensating for any eccentricities. The surface is ***actually smoother*** than a lathe-turned job.

No Delay! The **IDEAL** way is the "Do It Now" way No dismounting, no moving, no shop work.

SIZES AND GRADES FOR ALL CONDITIONS—PROMPT DELIVERY

Other **IDEAL** Motor Maintenance Equipment: Precision Grinders, Mica Undercutters, Carbon Brush Seaters, Commutator Cleaning Stone, Commutator Saws and Milling Cutters, Slotting Files, Hand-Type Slotter and Scraper

Sold through AMERICA'S LEADING WHOLESALERS

IDEAL INDUSTRIES, Inc.

(Successor to Ideal Commutator Dresser Co.)

1033 PARK AVENUE **SYCAMORE, ILLINOIS**

1933

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

PRIME MOVERS

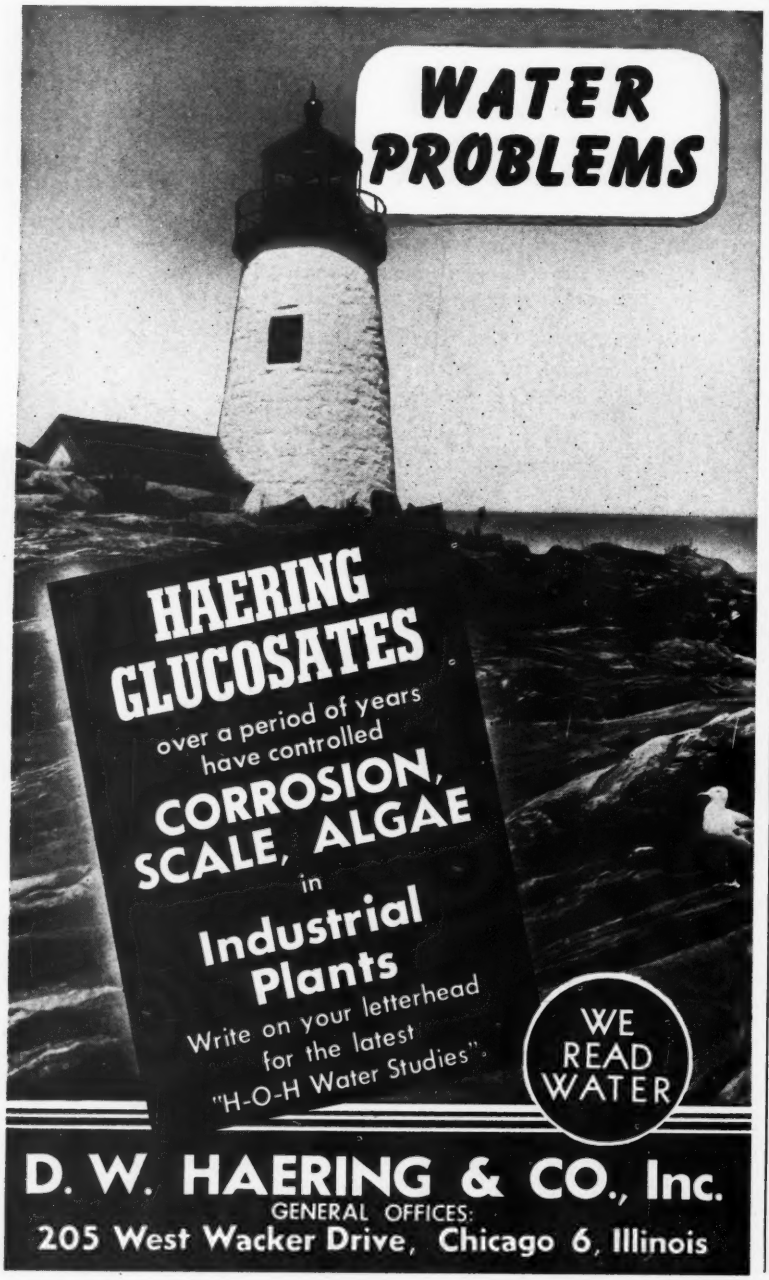
51 **Wheel Turbines**—Explanation of 14 advantages; diagrammatic illustrations and explanations of operation; 8 pages. Terry Steam Turbine Co.

52 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

53 **Multi-Stage Turbine** — Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

54 **Steam Engines** — Bulletin No. 306; Engineering data; tabular material descriptions; 8 pages. Troy Engine & Machine Co.

55 **Generating Sets** — Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.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HAERING GLUCOSATES
over a period of years have controlled
CORROSION, SCALE, ALGAE
in
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Write on your letterhead for the latest "H-O-H Water Studies".
WE READ WATER
D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Illinois

STOKERS

56 **Stoker**—Catalog H; Type H stoker; cross-sectional installation drawing; features of ash discharge; typical installations; 10 pages. American Engineering Co.

57 **Air-Cooled Stoker**—**Catalog R-A**; features of construction; how timing device works; installation drawings, ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 pages. American Engineering Co.

58 **Water - Cooled Stoker** — **Catalog** W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

59 **Spreader Stoker**—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

60 **Pneumatic Spreader Stoker**—Threefold booklet on the inner page of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

61 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

OIL, GAS BURNERS

62 **Oil Burning Systems**—Bulletin 45-1; three types of systems; drawings, tables of capacities and descriptions; photos; 4 pages. Faber Engineering Co.

63 **Mechanical Oil Burners** — Bulletin 45-2; two systems; drawings, tables of capacities and descriptions of units; parts list; 4 pages. Faber Engineering Co.

64 **Oil and Gas Burners**—Bulletin 45-3; combination burner; photos, drawings, tables; 4 pages. Faber Engineering Co.

65 **Wide Range Oil Burning System**—Bulletin 109; How the system operates; control; drawings; 4 pages. Peabody Engineering Corp.

66 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

67 **Gas Burners** — Bulletin 203; description of A and H gas burners; cross sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

68 **Gas and Oil Burners for Oil Refinery Furnaces**—Bulletin 702; details of firing with gas, with oil; photos; drawings; 4 pages. Peabody Engineering Corp.

WATER TREATMENT

69 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Co., Inc.

70 **Industrial Water Treatment**—Microbiological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality by proper sterilization. Wallace & Tiernan Co., Inc.

71 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Co., Inc.

72 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Co., Inc.

73 **Index for Calcium Carbonate** — Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

74 **Water Treatment**—Bulletin 28S; Scale retardent for use in boilers, feedlines, heaters, etc.; drawing of points of application; composition; 4 pages. National Aluminate Corp.

75 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

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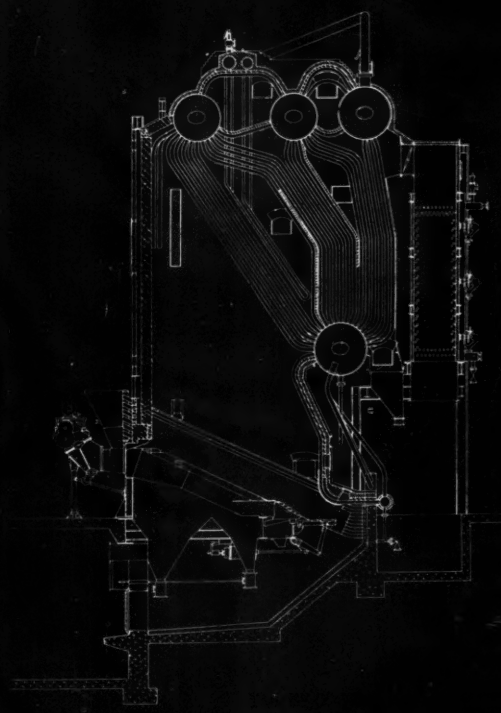

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86 **V-Belt Drives**—Catalog 280-A; 15 pages on V-belt drives for standard motor speeds; 41 pages on V-flat drives, how to select, advantages; nine pages on supplementary drive tables; 13 pages of engineering data; 16 pages prices and dimensions; total 112 pages. The Dayton Rubber Mfg. Co.

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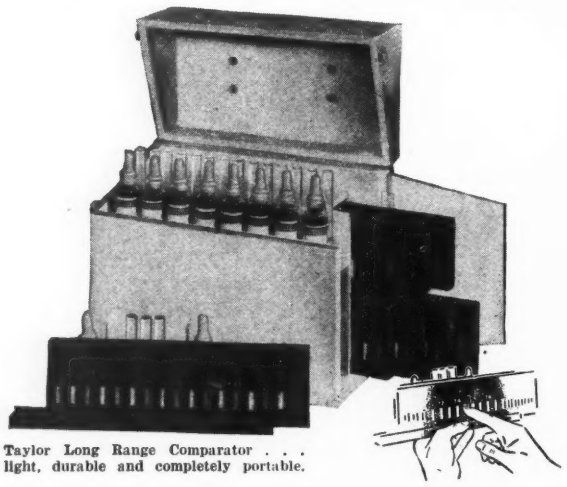

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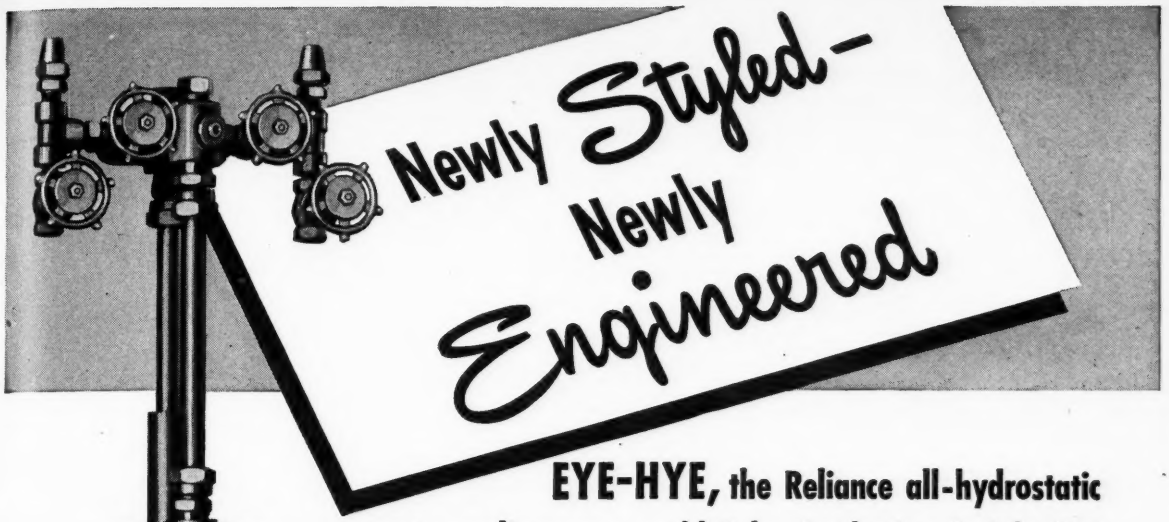

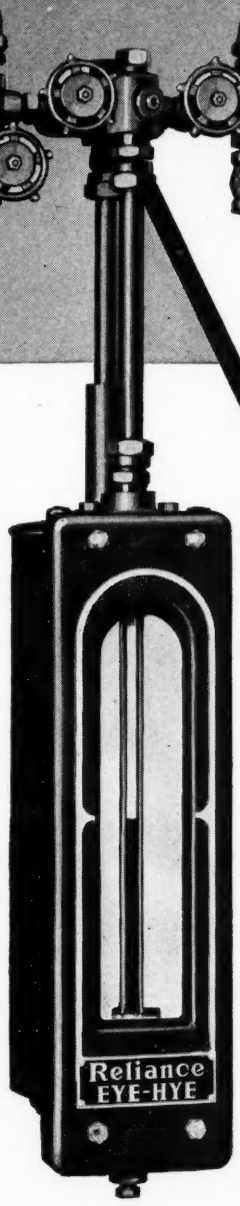

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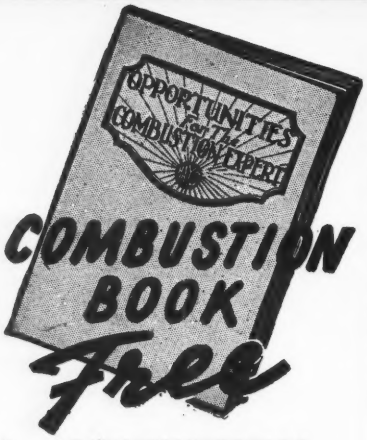

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103 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

CONTROLS, METERS

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105 **Pump Governors** — Bulletin 403-A reciprocating, turbine-driven, motor-driven pumps; selection of governor; construction; pressure, capacity tables; installation; sizing; specifying; dimensions; 12 pages. Leslie Co.

106 **Temperature Regulators** — Bulletin 404-A; heating or cooling service; selection of regulator; temperature and pressure ranges; installation; various types described and pictured; ordering and specifying; complete tabular material; 16 pages. Leslie Co.

107 **Damper Regulators**—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

108 **Pump Governors**—Bulletin 2-B; photos, descriptions, list prices, dimensions and weights in tables; operation and adjustment; installation drawings; 20 pages. Atlas Valve Co.

109 **Engineering Monographs** — Series of eight on automatic combustion control; 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

110 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; descriptions of equipment; differential units, Bourdon tube units, pointer gages, etc.; 20 pages. The Hays Corp.

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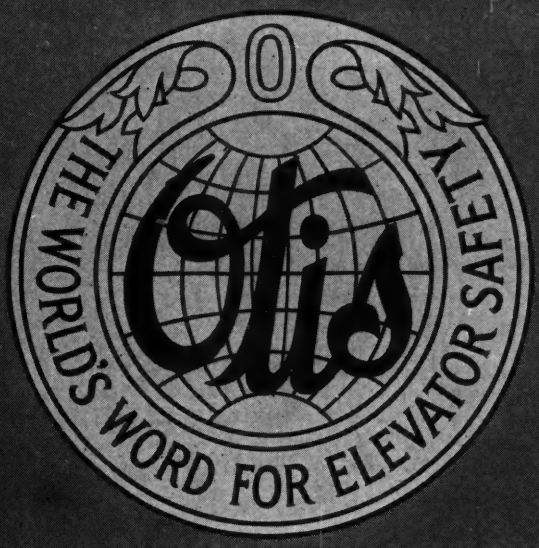

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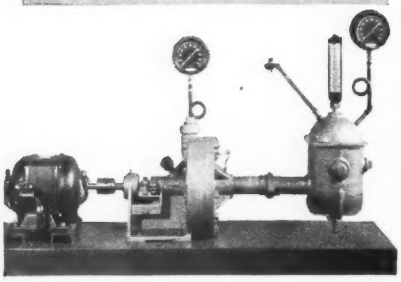

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128 **Propeller-Type Meter**—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

129 **Feedwater Textbook** — "Mechanical Feedwater Regulation for Boilers" by Prof. E. P. Culver; principles of feedwater regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

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132 **Packings**—Bulletins P3, P14, P25 and P22; descriptions, tables of size and size number; tables of service for various packings; prices; 18 pages total. Greene, Tweed & Co.

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134 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

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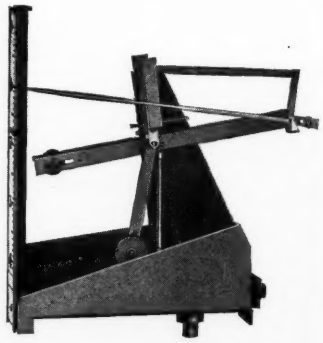

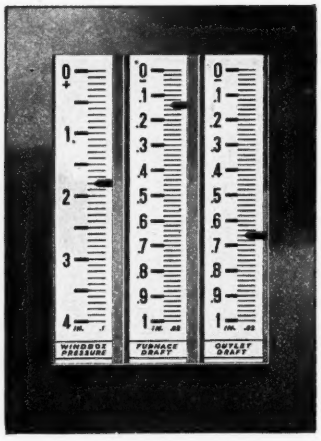

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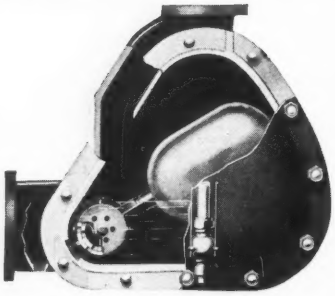

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155 Power Plant, Industrial Process Equipment—Steam turbines, turbine generators, mechanical drive turbines; motors and generators; feed-water heaters and deaerators; condensers and auxiliaries; steam jet ejectors; centrifugal blowers; turbochargers for diesels; accessories and tube cleaners; completely illustrated; 20 pages. Elliott Company.

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161 Flexible Metal Hose—Bulletin H-201-935; book gives general information, pitch, available alloys, armoring, tables of weight, pitch, pressures, diameters, etc.; descriptions of typical uses; drawings, descriptions of fittings; assembly instructions, specifying information; drawings and photos; 24 pages. Eclipse-Pioneer, Div. of Bendix Aviation Corp.

162 Fluid Handling Equipment—Catalog 45; for industrial, power plant, process industries; descriptions, tables on strainers, valve control boxes, check valves, safety vents, foot valves, backwater sewer valves, interceptors, intercepting drains and traps, solids interceptors, lint interceptors, floor and area drains, etc.; completely illustrated; 12 pages. J. A. Zurn Mfg. Co.

163 Metal Forging—Reference Data Book; types and characteristics of forgings; design; process operations; metallurgy; metal defects; machining; inspection; applications; tables and illustrations; 40 pages. The Steel Improvement & Forge Co.

BOOK REVIEWS

(Continued from Page 162)

An Introduction to Electronics, by Ralph G. Hudson, First Edition, 97 pages, size 5¾ by 8½ inches, cloth, published by the Macmillan Company, 60 Fifth Avenue, New York, N. Y., 1945. Price $3.00.

This book explains the science of electronics and its modern application in terms that will be understandable and useful to those with only an elementary knowledge of mathematics and physics. It gives the reader a clear and scientifically exact knowledge of the modern theory of the constitution of matter and the nature of an electric current in a gas, a liquid, a solid and in a vacuum. It describes and illustrates all of the major uses of electronic tubes and phototubes, the construction of electronic devices and their working principles.

The book begins with a non-mathematical explanation of the basic laws and phenomena of electronics, the structure of matter as it is now known

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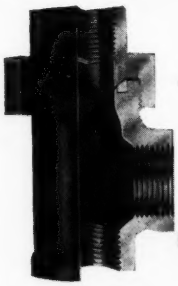

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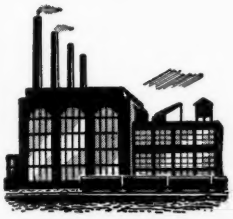

POSSIBLE INDUSTRIAL APPLICATIONS INCLUDE USE TO PURIFY HIGH PRESSURE BOILER FEED WATER

American commanders of troops assaulting the Pacific islands never had to worry about water for their men.

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The link between the salty Pacific and pure drinking water was a distillation unit so efficient that a gallon of fresh water was obtained from the same heat input needed to bring a quart of water to the boil on a kitchen stove.

The unit was . . . ***the Badger-Kleinschmidt Vapor Compression Water Still,*** developed by Dr. R. V. Kleinschmidt of Arthur D. Little, Inc. and manufactured by E. B. Badger & Sons Co., Boston, Mass.

A major problem in designing the unit was the selection of materials. Combat use permitted a minimum of maintenance.

To counter the abrasive and corrosive conditions, nickel alloys were used throughout. For example, all sheet metal parts were made of a copper-nickel alloy. All nuts, bolts, studs, tie-rods, piping and other fittings were Monel.

With nickel alloys on the job it was no wonder that reports came back from the Pacific telling of Badger-Kleinschmidt stills operating smoothly even after their steel framework and housing had almost been completely eaten away.

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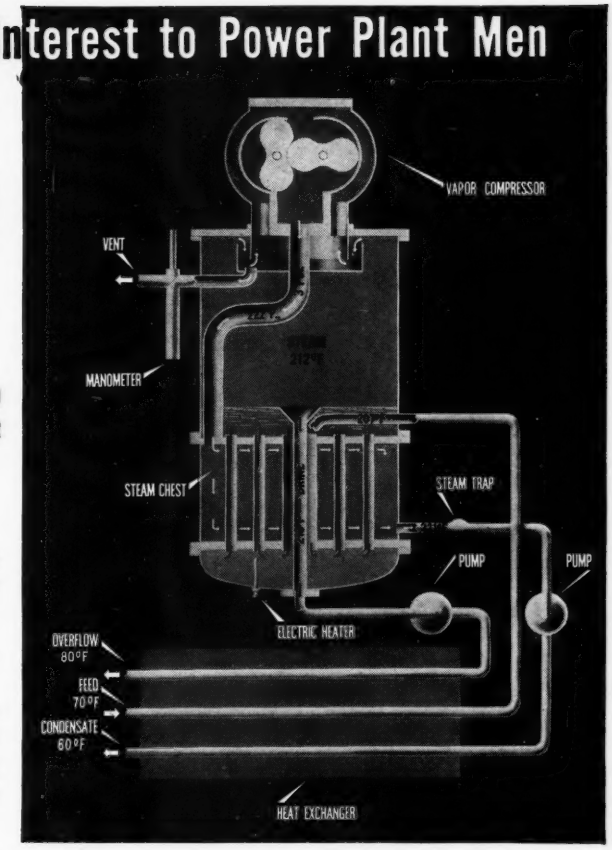
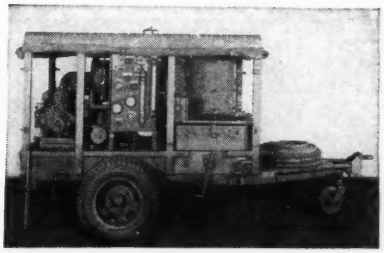


OPERATING PRINCIPLE

THE VAPOR COMPRESSION STILL'S conservation of heat is a close approach to perpetual motion. Feed water intake is through a heat exchanger. Sandwiched between concentric pipes carrying hot condensate and brine overflow, the feed water is raised to 207° F. Passing to the steam chest, it circulates through tubes surrounded by compressed steam at 222° F. This boils the water. The generated steam then goes to the compressor where it in turn is boosted to 222° F. Passing into the steam chest, it gives up most of its latent heat and boils new feed water. Then it passes through the heat exchanger and emerges as potable distillate.

In diesel-powered units, the exhaust supplies all the heat. In electric units, a separate electric heater is used. Thermal efficiency is 15 times that of ordinary single-phase stills.

TWO PUMPS are used on every B-K still. Many units are equipped with Warren SED vertical pumps. The SED, manufactured by WARREN STEAM PUMP Co., Warren, Mass., has a 1¼" Monel shaft and a "K" Monel shaft sleeve.



A PORTABLE B-K STILL used by the Army, Marines and Seabees. Fixed installations were aboard submarines and other Navy craft. E. B. BADGER & SONS Co. is ready to make stills up to capacities of 100,000 gallons per day. With these large-scale models available to economically distill high-pressure boiler feed water, boiler corrosion may well be licked.

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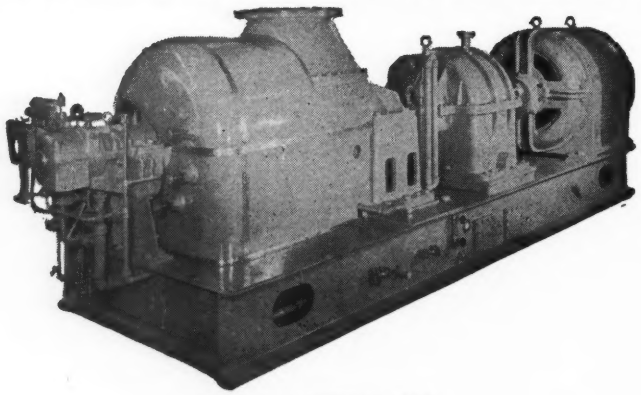
MURRAY
TURBINE GENERATORS



500 KW—PACKAGE TYPE

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Equipment included trip and throttle valve, oil relay governor controlling single throttling inlet valve with hand valve control for partial load operation, all service connections above floor line except generator leads, drain piping brought to one point, and structural steel baseplate. The baseplate is sufficiently rigid so that the unit can be handled in one piece, and installed on the simplest of foundations.

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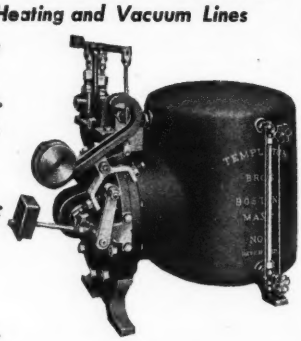

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and the principles of the conduction of electricity. The manner in which these theories have been evolved and have been checked by experimentation is also briefly reviewed. These chapters are simply written but not elementary. They give an accurate idea of the meaning of such terms as isotopes, quanta of energy, ionization, positron and mesotron, the fundamental electric units of measurement and their relationship. On the whole this is one of the best simple books on electronics that we have seen.

Ralph G. Hudson, the author, is Professor of Electrical Engineering and Chairman of the courses in general science and general engineering at the Massachusetts Institute of Technology.

Conductors and Wiring Layouts, by E. S. Lincoln, First Edition, 342 pages, 5½ by 8¼ inches, illustrated, cloth, published by Duell, Sloan and Pearce, 270 Madison Avenue, New York, N. Y., 1945. Price $3.00.

This book describes in detail the construction and operation of every type of conductor and conductor insulation. It also provides instructions for wiring motors, welders, capacitors, switchboards, lighting and communication systems, as well as appliances and layouts for services, feeders, and branch circuits. Hand splicing for small conductors and mechanical pressure connectors for all conductors are covered by the text which is supplemented by helpful diagrams and photographs.

The book includes many tables analyzing the current-carrying capacities of conductors under all operating conditions and special graphic tables which simplify the problems of motor wiring.

Electric Circuits and Machines, by Eugene C. Lister; First Edition; 358 pages, 5½ by 8½ inches; illustrated; cloth; published by the McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York, N. Y.; 1945. Price $3.50.

This book constitutes an introduction to practical electricity. Electric circuits and machinery are made easily understandable to the readers of this book, for the emphasis has been placed on the physical action that occurs rather than on a detailed analysis of the theory involved. In a simple, concise manner the author presents the overall picture of the electrical field, including the fundamentals of both direct and alternating currents, circuits and machines with which a technical man must be familiar.

The treatment is as non-mathematical as practicable, and the mathematics are limited largely to simple algebra. Many numerical examples are worked out in detail and a list of problems is included in those chapters where the solution of problems will illustrate the application of the principles involved.

The review questions at the end of each chapter may be used for class discussion or a study aid by the student for evaluating his grasp of the subject matter.

The author was formerly Supervisor of Electrical Theory Instruction, Specialized Training Program in Iowa State College, 1942-44. He is now with the Stanley Engineering Company.

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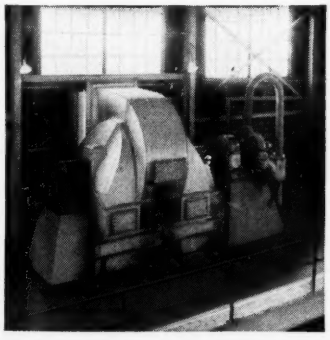

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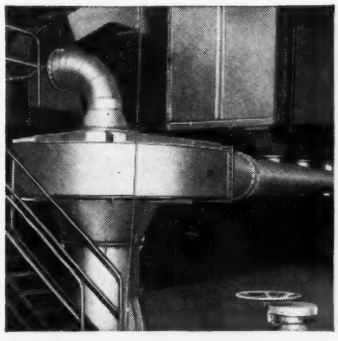

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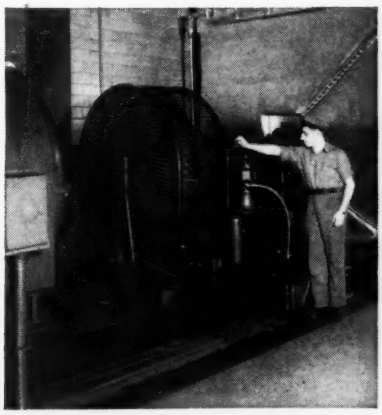

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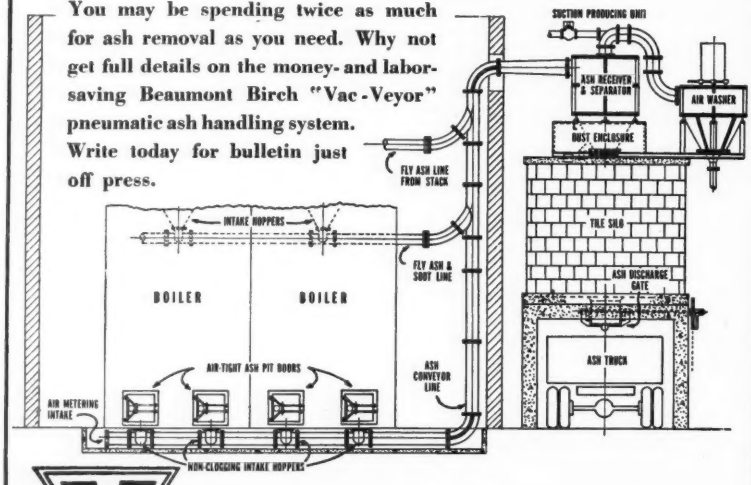

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Repair Shop Diagrams and Connecting Tables for Lap-Wound Induction Motors, by Daniel H. Brayner and A. C. Roe, Second Edition, 387 pages, illustrated, size 6 by 9 inches, cloth, published by the McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y., 1946. Price $3.50.

This book is a practical step by step guide for repairmen and armature winders on the laying out of coils for induction motor windings, and connecting the ends of the groups of these coils in proper sequence of phase and pole groups for different types of windings used in motors of from 2 to 24 poles, two- and three-phase. The information presented can also be used when reconnecting the coil groups, to satisfy changes in voltage, changes for operation on circuits of different number of phases, different frequencies or changes in speed of a motor. Each diagram in the book is a practical shop drawing, marked with proper connections for the ends of all phase groups of coils so that they can be actually followed by the winder when making the connection.

The first edition of this book was published nearly 20 years ago. While the material in the first edition was still good, many changes and advances in the design and construction of induction motors during recent years made it advisable to revise the previous work. All the old data which was still fundamentally sound, has been retained but new material has been added to broaden the scope of the book.

Marine Engineers' Handbook, by J. M. Labberton and Lionel S. Marks; copyright 1945, first edition; 5 by 7 inches, 1951 pages, illustrated, cloth cover; McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York 18, N. Y. Price $7.50.

This book constitutes a new edition of Sterling's Marine Engineers' Handbook, once the "Bible" of the marine engineering profession, now brought up to date and made almost a completely new book under the editorship of Professor J. M. Labberton, Professor of Marine Engineering, New York University, with the general engineering fundamentals reproduced from Marks' Mechanical Engineers' Handbook with the co-operation of Lionel S. Marks. It begins, like Marks Handbook, with the same authoritative sections on mathematics, weights and measures, mechanics, friction, hydraulics, dimensional analysis, properties of materials, mechanics of materials, pipe and pipe fittings and so on.

However, when the reader reaches Section 8 on Power Generation, Boilers, Steam Engines and Steam Turbines and Internal Combustion Engines, he finds here the emphasis on details of equipment and methods of marine practice very well brought out. Following this, there are chapters on strictly marine practice such as those on Hulls, Propellers, Deck Machinery and Electric Drive.

In the concluding chapters on Heating and Ventilating, Pumps and Compressors, Fans, etc., there is much material of special interest to the marine engineer, such as discussion of refrigerating tonnage on board ship and special lubrication problems. The final chapter gives details on testing and trials.

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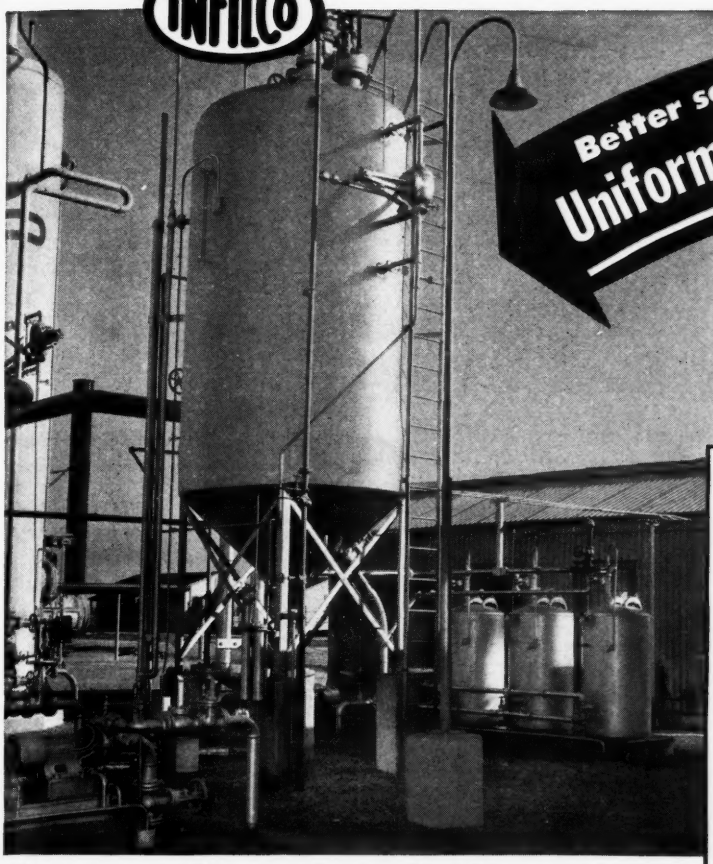

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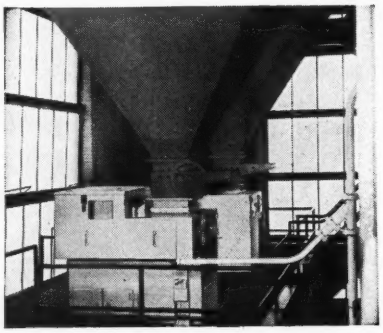

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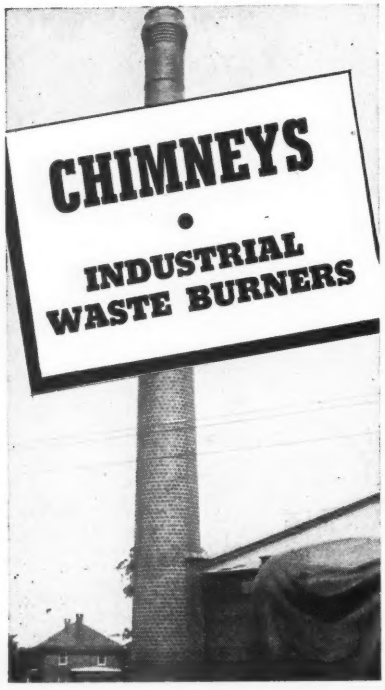

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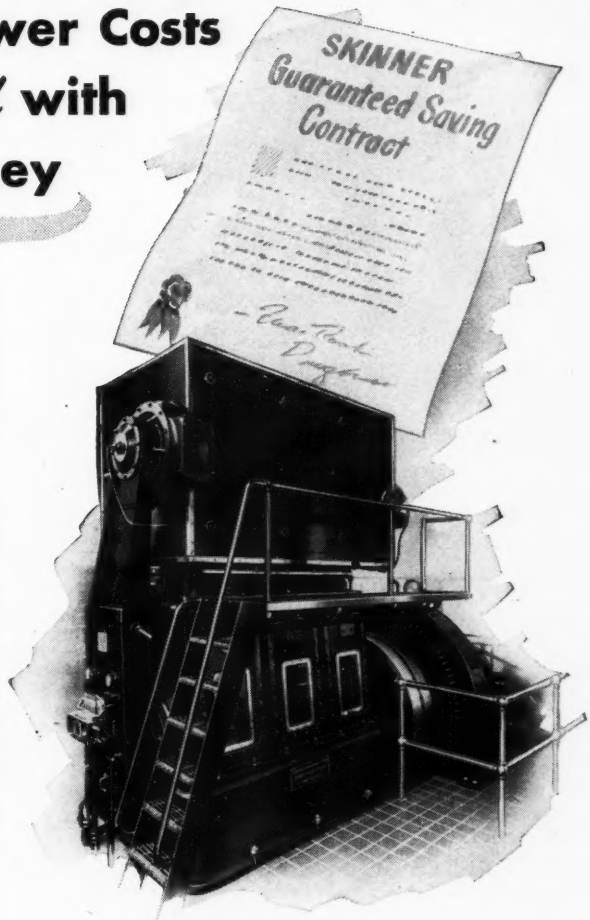

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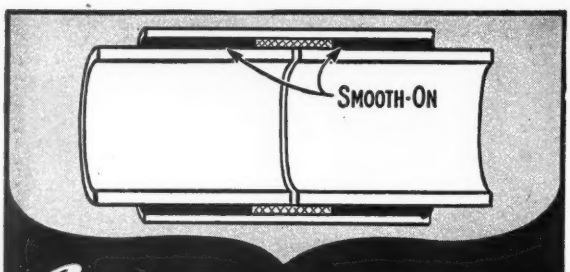

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POWER PLANT *Construction News*

Ark., Fort Smith—Dixie Cup Co., 421 North Western Ave., Chicago, Ill., paper cups, plates, etc., plans installation of electric power equipment on U.S. Hy. 71, near city limits, Fort Smith, comprising a large one-story building for general production, and several auxiliary structures. Entire project estimated to cost about $500,000. Erection has been approved by CPA, Federal agency, and work will begin soon.

Calif., Richmond—American Radiator & Standard Sanitary Corp., Critchett and Essex Sts., plans installation of electric power equipment in new two- and three-story addition to local sanitary ware plants, totaling about 200,000 sq. ft. floor space. Entire project will cost about $2,500,000. Proposed to begin work soon. Prack & Prack, 130 Federal St., Pittsburgh, Pa., are architects and engineers. Main offices of company are in Bessemer Bldg., Pittsburgh.

Ga., Thomasville—Water and Light Department plans expansion and improvements in municipal steam-electric power plant, including installation of additional equipment. Work will be carried out in conjunction with extensions in waterworks station, entire project reported to cost close to $200,000.

Ind., Edwardsport—Public Service Co. of Indiana, Indianapolis, Ind., plans expansion in steam-electric generating station at Edwardsport, including installation of new 37,500 kw turbine-generator unit, high-pressure boiler and auxiliary equipment. Switchyard will be enlarged and extensions made in transmission lines. Cost reported about $5,000,000. Proposed to carry out project in near future. Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., are consulting engineers.

Ind., Fort Wayne—Indiana Service Corp., Spy Run Ave., has authorized new power substation on local site, with transformers, switchgear and accessories for capacity of 45,000-kva. Also will make extensions in transmission lines in different parts of city and nearby areas. Entire project is estimated to cost approximately $1,000,000. Work scheduled to begin soon.

Iowa, Ottumwa—Iowa Southern Utilities Co., Centerville, Iowa, plans extensions in steam-electric generating station at Ottumwa, including installation of new turbine-generator unit, boiler and auxiliary equipment. Cost estimated close to $1,000,000, including extensions in transmission lines. Federal Engineering Co., Putnam Bldg., Davenport, Iowa, is consulting engineer.

Ky., Louisville—Brown-Forman Distillers Corp., 1908 Howard St., whiskey distiller, plans power plant in connection with new bottling works, storage and distribution plant on Dixie Hy., near Garland Ave. Project will include five large multi-story buildings. Electric power equipment will be installed for production service, as well as mechanical-handling and other facilities. Entire development will cost over $2,500,000. Proposed to begin work soon. Joseph & Joseph, 647 South Third St., Louisville, are architects.

La., Baton Rouge—Solvay Process Co., North Baton Rouge, industrial chemicals, calcium chloride, alkalis, etc., plans installation of electric power equipment in connection with proposed expansion in local plant. Power plant will be enlarged. Proposed to begin work in near future. Entire project estimated to cost over $1,500,000. Main offices are at 40 Rector St., New York, N.Y.

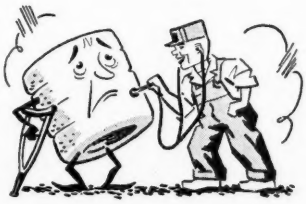
La., Eunice—City Council has plans nearing completion for new municipal power plant, reported to cost about $250,000, including distribution lines. Also will make extensions and improvements in municipal waterworks plant and system, to cost approximately $260,000. Barnard & Burks, Triad Bldg., Baton Rouge, La., are consulting engineers.

Md., Cedarhurst—Congoleum-Nairn, Inc., 195 Belgrove Dr., Kearny, N.J., felt-base floor coverings, linoleum, etc., plans installation of electric power equipment in new one-story addition to felt mill at Cedarhurst, reported to cost close to $1,000,000, with machinery. Work on superstructure will begin at early date.

The Stuffing Box

TIPS ON GOOD PACKING PRACTICE

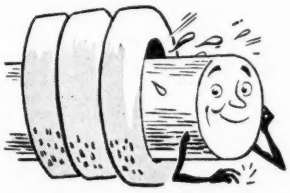
NO. 4 OF A SERIES



Used packing, if examined carefully, often points the way to better service from new packing. From it, you can learn much about the condition of your equipment and so find the solutions to many of your packing problems.

Here are some ways to check on trouble . . . and correct it:

Measure the thickness of the packing as removed from the stuffing box. If the rings have been compressed on the side

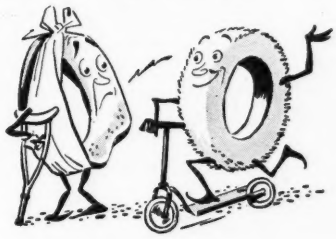


which lies directly under the rod, it indicates that the rod or shaft is out of line and riding the packing. This results in leakage around the top of the rod or stuffing box.

Applying excessive gland pressure when the rod or shaft is out of alignment will mean reduced packing life, rapid wear and scoring, and waste of power. The best remedy is to align the shaft.

If the rings next to the gland follower are badly deformed with the bottom rings in fair condition . . . look for improperly installed packings or excessive gland pressure.

Do your packings show a tendency to sheet out or extrude between the rod or shaft and the gland follower? If so, the gland pressure may be excessive, or, more likely, there is too much clearance between the rod or shaft and the gland follower.



A bulge in the side of one or more rings can safely be blamed on cutting the adjacent rings too short. This causes the packing to be forced under pressure into the open space.

Unusual wear on the outside diameter of the packing is probably due to one of two conditions (1) the rings are rotating with the shaft . . . (2) the packing is loose and moving with the rod.

A worn bushing in the bottom of the stuffing box sometimes causes extrusion of the packing into the system. When this happens, the fragments of packing may get into and clog valves or traps or contaminate the fluid being pumped. Examination of the bottom ring will readily indicate whether or not this condition exists.

A dried and charred wearing face, with the rest of the packing in good condition, indicates insufficient lubrication. Remember that careful lubrication can do a lot to prolong the life of your packing.

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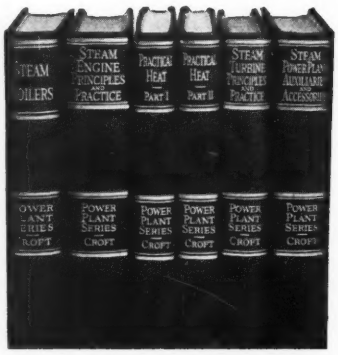
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Mass., Erving—Erving Paper Mills, tissue, crepe and kindred papers, plans new boiler house at mill, reported to cost close to $45,000, with equipment. Project has been approved by CPA, Federal agency, and work will be placed under way soon.

Minn., Hayfield—Village Council is having plans completed for new municipal power plant, using Diesel engine-generator units and accessories. Cost estimated about $191,000, including distribution system. Proposed to carry out work at early date. Toltz, King & Day, Inc., Pioneer Bldg., St. Paul, Minn., is consulting engineer.

Miss., Jackson—Mississippi Power & Light Co., Jackson, has plans under way for new generating station on site outside city limits, to be equipped for initial capacity of 30,000-kw. Turbine-generator of that rating will be installed, with high-pressure boiler and auxiliary equipment. Extensions will be made in transmission lines. Entire project reported to cost close to $4,500,000.

Mo., Ava—Town Council is considering new municipal electric power plant. Proposed to use Diesel engine-generator units and accessories. Cost reported about $125,000.

Mont., Billings—Carter Oil Co., National Bank of Tulsa Bldg., Tulsa, Okla., plans power plant in connection with new oil refinery at Billings, where large tract of land has been selected. Also will install pumping station, pressure steel tanks for storage and distrribution and other mechanical equipment for oil and gasoline service. Plant will have capacity for handling 18,000 bbl crude oil per day and will represent gross investment of about $8,000,000. Proposed to begin work at early date. Company is a subsidiary of Standard Oil Co. of New Jersey, 26 Broadway, New York, N.Y.

N.Y., College Point—I. B. Kleinert Rubber Co., 485 Fifth Ave., New York, N.Y., household rubber goods, proofed products, etc., plans installation of electric power equipment in new one-story addition to plant at 126th St. and 20th Ave., College Point, L.I. Cost reported about $100,000. Proposed to begin work at early date.

N.C., Rocky Mount—Public Utilities Department will have plans prepared soon for extensions and improvements in municipal steam-electric power plant, with installation of equipment for large increased capacity. Cost estimated about $1,040,000. Financing in part is being arranged through Federal aid.

N.C., Washington—Electric and Water Department has plans under way for extensions and improvements in municipal steam-electric power plant, with installation of equipment for increased capacity. Also will make additions to municipal distribution system. Bond issue of $400,000 has been authorized for project. W. C. Olsen, 5 Exchange Pl., Raleigh, N.C., is consulting engineer.

Ohio, Bluffton—Central Ohio Light & Power Co., Findlay, Ohio, has approved plans for immediate expansion in generating station at Bluffton, known as Woodcock plant, including installation of new turbine-generator and accessories. Cost reported about $650,000.

Okla., Newkirk—Town Council has plans maturing for extensions and improvements in municipal power plant. New Diesel engine-generator and accessories will be installed. Cost about $85,000. Bond issue in that amount has been approved. H. R. Hunter, 105 West English St., Wichita, Kan., is consulting engineer.

Ore., Portland—Starr Fruit Products Co., 105 S.E. Yamhill St., canned fruits, plans installation of electric power equipment in new local processing and canning plant at Vancouver Ave. and Columbia Blvd., reported to cost about $550,000. A boiler house will be built. Proposed to carry out work in near future.

Tenn., Dyersburg—Water and Light Department has plans in progress for expansion and improvements in municipal steam-electric power plant, including installation of equipment for increased output. Bond issue of $150,000 has been authorized for this and extensions in water system. Proposed to carry out work in near future.

Wash., Seattle—Board of Directors, University of Washington, has plans under way for new four-story electrical engineering building at institution, estimated to cost about $800,000, with equipment. Bids for erection are scheduled to be asked in near future. Pau. Thiry, Third Ave. Bldg., is architect, and John Paul Jones, Hoge Bldg., supervising architect, both Seattle.

Wis., Appleton—Institute of Paper Chemistry, 1101 East South River St., has plans for new boiler house, about 40 x 64 ft. Orbison & Orbison, 206 West College Ave., Appleton, are consulting engineers.

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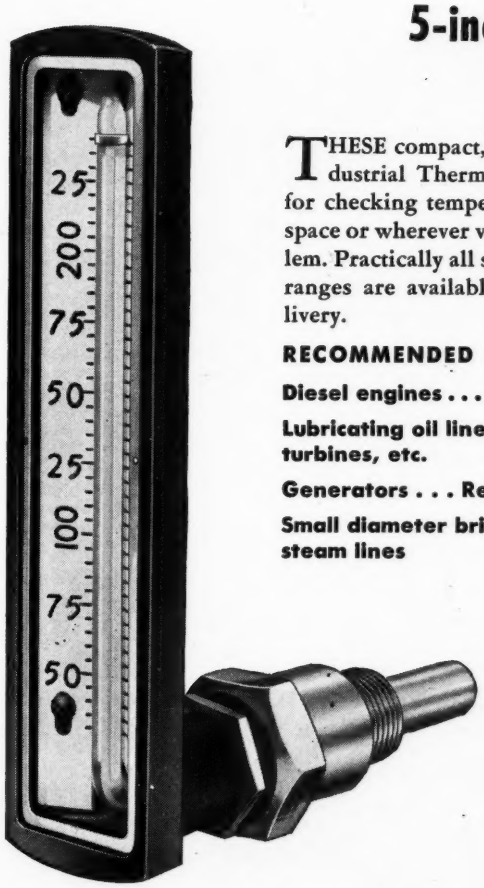

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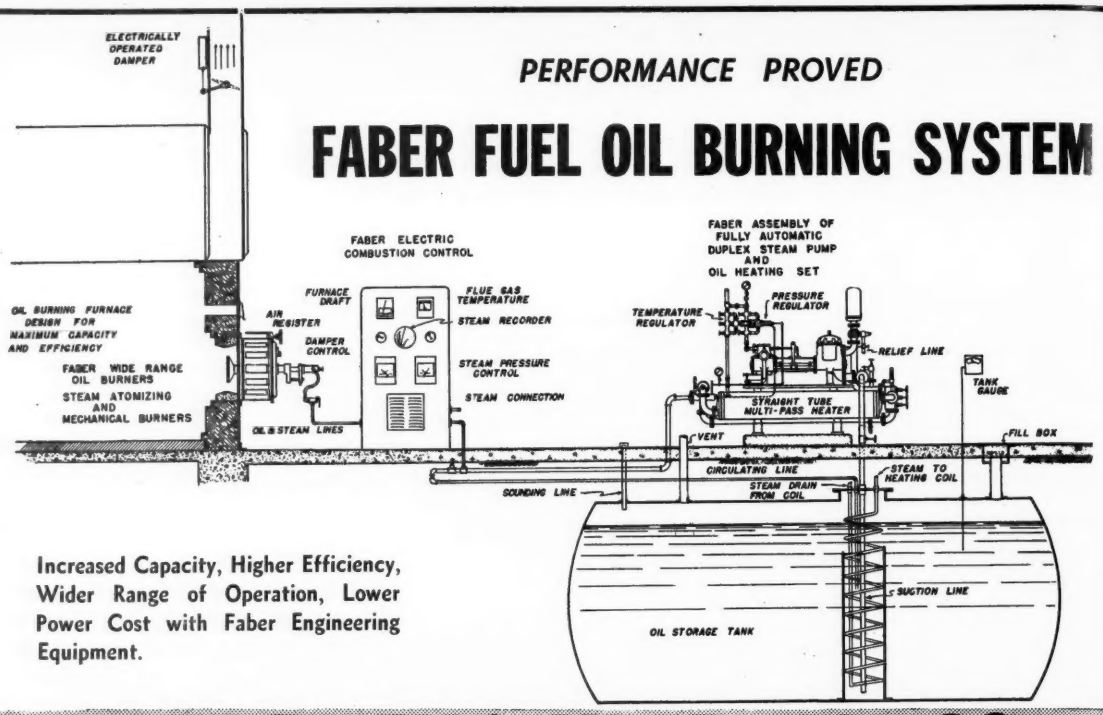

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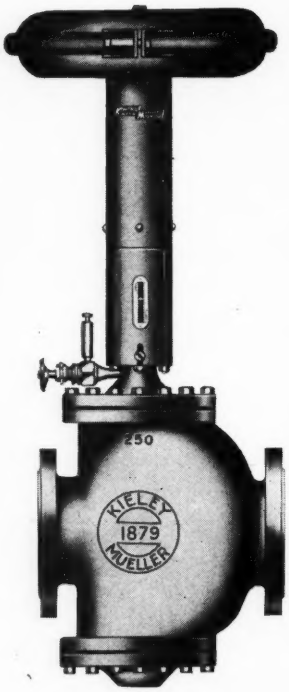
SOMETHING NEW HAS BEEN ADDED

Write for new Kontrol Motor bulletin. Send us your control problems.

KIELEY & MUELLER, INC., North Bergen, N. J.

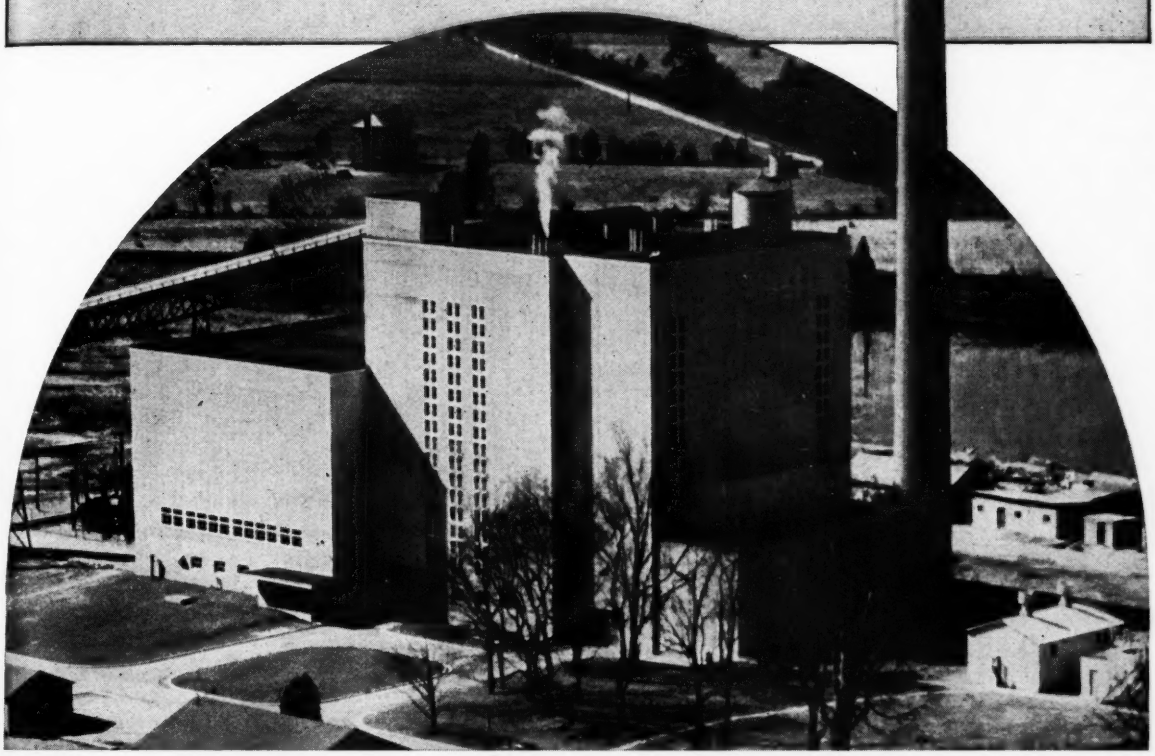
KONTROL KIELEY & MUELLER MOTOR

SEE OUR EXHIBITS—
BOOTH 155, NAT. CHEMICAL EXPOSITION
BOOTH 158, INST. SOCIETY OF AMERICA



- ***All Steel Diaphragm Motor Unit...***
  lighter, tougher, stronger, more durable
- ***Boltless "Duoseal" Diaphragm Casing...***
  tight sealing, quick acting clamp ring; molded highly flexible neoprene diaphragm
- ***Steel Tubular Yoke...***
  enclosing long, heat-treated, cadmium plated spring; packing gland and spring adjustment accessible through door
- ***Valve Position Indicator...***
  standard equipment; no extra charge
- ***High Capacity Valve Bodies...***
  unrestricted flow areas, smooth flow; available in bronze, semi-steel, cast steel, and special alloys
- ***Superfinished Disc Guides...***
  top and bottom guided Bevel, Percentage V Port, and Parabolic discs; minimum friction, increased life
- ***Modern Design...***
  to meet modern process requirements for better control

TURNING DEMAND INTO SUPPLY



Chesterfield Station, Virginia Electric & Power Company, near Richmond, designed and constructed by Stone & Webster Engineering Corporation. Another new power plant for this client is now in the design stage.

Because of the necessary curtailment of normal power plant construction during the War, the nation's utilities and industrial plants must now increase their power generating capacity to meet the growing needs of peacetime production.

New steam and electric generating facilities and plant extensions, using turbine units ranging from 1,500 to 80,000 KW and boilers ranging from 20,000 to 650,000 pounds of steam per hour, now on the design boards of Stone & Webster Engineering Corporation, will have a total capacity of 673,500 KW and 10,300,000 pounds of steam per hour.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

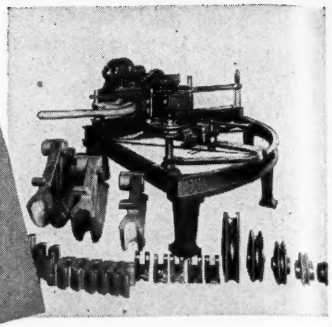
A Mercoid Product

The Mercoid Sensatherm is emerging in this post-war period unexcelled in its simple beauty, with its appealing lifetime lustrous natural metallic finish. There is no lacquer coating to become dull, nor can it ever tarnish. It holds its newness in appearance indefinitely. No polishing or scrubbing is ever necessary—simply wipe off any accumulated dust or dirt with a damp cloth, in fact a dry cloth usually does quite as well.

And speaking of performance, this instrument still remains unmatched for its even room temperature control. There are many factors in its design and construction contributing to its long life and positive operation, particularly the hermetically sealed mercury switch. Summing up its appearance and performance, the Mercoid Sensatherm is truly the aristocrat among thermostats

THE MERCOID CORPORATION · 4203 BELMONT AVE. · CHICAGO 41 · ILL.

BENDS PIPE EASILY AND QUICKLY INTO ALL SHAPES



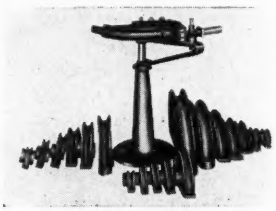
"American"

COLD PIPE, CONDUIT and TUBE BENDING MACHINES

Twelve types to select from.
Hand operated capacities ¼ to 6" inclusive. Motor operated ¾ to 8" inclusive.

A few of Our More Than 12,000 Customers:

Kaiser Shipbuilding Co.; Bethlehem-Hingham Shipyards; Portsmouth Navy Yard; Moore Drydock Co.; Stone & Webster Engineering Corp.; E. I. DuPont deNemours & Co.; West Penn Power Co.; Illinois Central Railroad; Federal Pipe & Supply Co.; Alabama Drydock Co.; Westinghouse Elec. & Mfg. Co.; Todd-Bath Shipbuilding Co.



Write Air Mail for printed matter.

"American" PIPE BENDING MACHINE Company INC

Quick Deliveries
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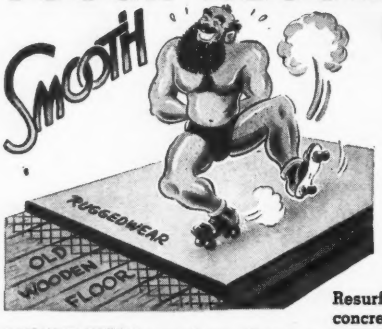
TOUGH RESURFACER

FOR BROKEN

Concrete or Wood Floors

Makes Durable Patch or Complete Overlay



Resurface or patch broken concrete floors with tough RUGGED WEAR resurfacer. Here's a material which will stand up under the most punishing traffic conditions. Simple to install—no chopping or chipping required. Merely sweep out the spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Provides a firmer, tougher, smoother, more rugged wearing surface. Use indoors or out. Dries fast.

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Canadian Office: 21 King St., E., Toronto, Ont.

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Company .....
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100% AUTOMATIC

FOR GAUGING LIQUIDS OF ALL KINDS

APPROVED BY UNDERWRITERS' LABORATORIES

WRITE for COMPLETE DETAILS

"LIQUIDS WORTH STORING ARE WORTH MEASURING"

THE LIQUIDOMETER CORP.
36-31 SKILLMAN AVE., LONG ISLAND CITY, L.I., N.Y.

PROBLEM:—

Installing a stack, dust collectors and dampers on two boilers and providing a bypass around the dust collectors, in the most compact space possible.

One Thermix Stack, serving both units, was connected to the boilers by a straight, short, horizontal breeching. Two SVH Heacon dampers regulated the flow through the dust collectors when partially open and, when fully opened, exposed the bypass. Two Thermix tubular dust collectors were easily installed by suspending them from the stack supports.

These units were all installed on a simple steel structure supported by the four boiler columns.

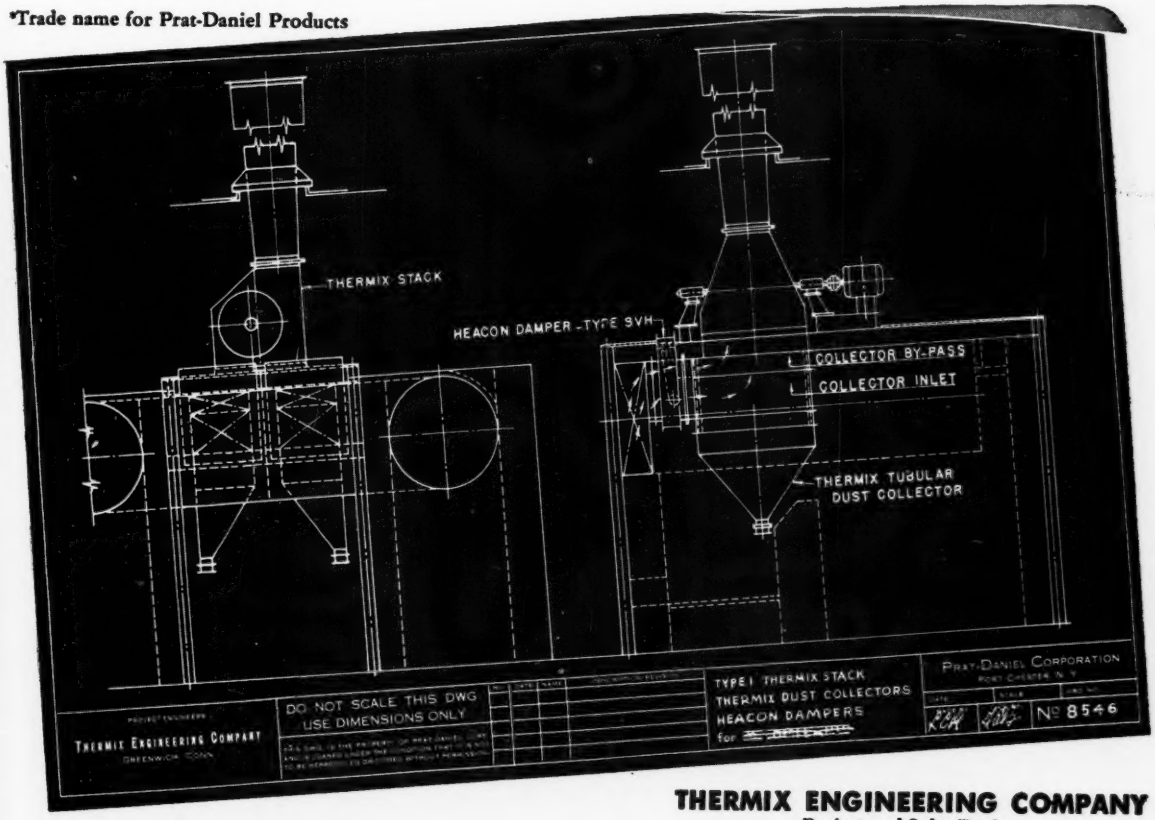
Thermix equipment is designed to simplify installation problems. The Thermix stack, for example, combines a stack breeching and I.D. fan in one integral unit that can be mounted directly on the boiler, or adjacent to the boiler, with a minimum of structural supports and duct work.

Our project engineers can simplify your installation problems; Write or call the office nearest you.

Simple-Direct-Efficient INSTALLATIONS

. . . are possible with "Thermix"* equipment

*Trade name for Prat-Daniel Products



THERMIX ENGINEERING COMPANY
Project and Sales Engineers
First National Bank Bldg. Greenwich, Conn.

PRAT-DANIEL CORPORATION
EAST PORT CHESTER, CONN.

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32 pages of authentic information covering sizes, weights, and pressure ratings make the handy Phoenix Flange Catalog a complete, thoroughly reliable guidebook for flange buyers.

Phoenix Flanges are drop forged from mild steel especially suited to welding and machining.

Every Phoenix Flange complies with ASA requirements and ASME and ASTM specifications.

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PHOENIX MANUFACTURING COMPANY
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A STATEMENT of ADVERTISING PRINCIPLES

1. Good Advertising . . .

aims to inform the consumer and help him to buy more intelligently.

2. Good Advertising . . .

tells the truth, avoiding misstatement of facts as well as possible deception through implication or omission. It makes no claims which cannot be met in full and without further qualification. It uses only testimonials of competent witnesses.

3. Good Advertising . . .

conforms to the generally accepted standards of good taste. It seeks public acceptance on the basis of the merits of the product or service advertised rather than by the disparagement of competing goods. It tries to avoid practices that are offensive or annoying.

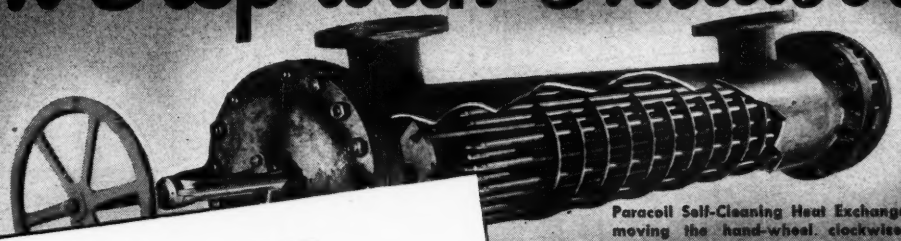
4. Good Advertising . . .

recognizes both its economic responsibility to help reduce distribution costs and its social responsibility in serving the public interest.

Advertising Federation of America

Power Plant ENGINEERING

In Step with Industry



Paracoil
HEAT TRANSFER EQUIPMENT

Davis Engineering Corporation has played a major part in the development, design betterment and manufacture of distillation, evaporation and heat exchange equipment for more than 30 years.

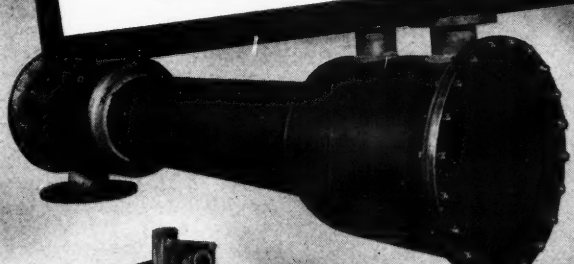
Pictured are Paracoil Heat Transfer units designed to serve America's industries as well in peace as they served the country during the war. Davis built heat exchangers assure greater production efficiency, reduced repair and cleaning costs and freedom from shutdown losses.

Paracoil equipment is available for practically every type of heat transfer application called for by our many and varied industries.

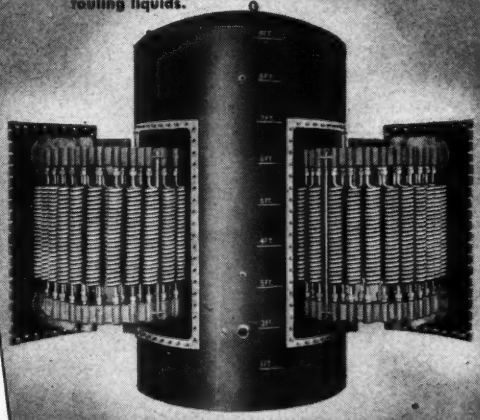
Technical and practical knowledge accumulated from 30 years of manufacturing experience and job performance, supplemented by continuous engineering research, have resulted in fundamental design improvements effecting advanced performance and increased resistance to severe service conditions.

Whether yours is a replacement, new, or more efficient equipment need, Paracoil Heat Exchangers are available on most reasonable delivery schedules and Davis engineers are ready to assist in making proper selection of size and design best suited for your particular problems.

To those with fouling problems: Write for bulletin HE-100 describing the Paracoil Self-Cleaning Tubular Heat Exchanger.



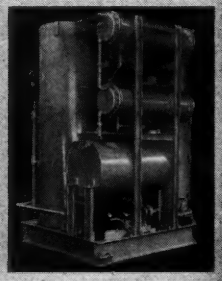
Paracoil Self-Cleaning Heat Exchanger. By moving the hand-wheel clockwise and counter clockwise the entire baffle-assembly is moved back and forth over the heating surface thus scraping any deposits from the tubes. Cleaning action is positive and effective. Ideal for heating fuel oil and other fouling liquids.



Paracoil Double-Door Evaporator. Note accessibility of all the heating surface for inspection, cleaning and ease of repair. Available in single and multiple effects and in a wide range of capacities.

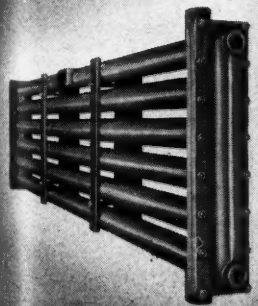
FRONT VIEW

Triple Effect Package Type Distillation plant built for supplying distilled water from sea water or contaminated water for drinking and process service. Illustrates Paracoil hinged door evaporators. A completely self contained unit.



BACK VIEW

This distillation unit has a capacity of 180 gallons per hour with low pressure steam and economical steam consumption. Other package types standardized for a number of capacities.



Gas to Gas Heat Exchanger. This type of Paracoil Heat Exchanger has many industrial uses for transfering heat between gases or liquids, or between gases and liquids. Unit illustrated constructed entirely of Inconel. Can be furnished in other alloys or carbon steel.

Liquid to Liquid Exchanger. Special liquid to liquid exchanger for counter current flow, six pass on both shell and tube sides. Most efficient design for crossing temperature conditions. Straight tubes easily cleaned.

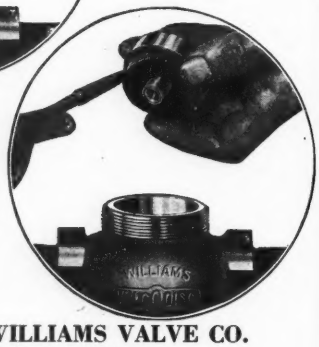
SINCE 1915
Paracoil
HEAT TRANSFER EQUIPMENT

DAVIS ENGINEERING CORPORATION
1069 EAST GRAND STREET, ELIZABETH 4, NEW JERSEY

Use VULCODISC

for trouble-free valve jobs

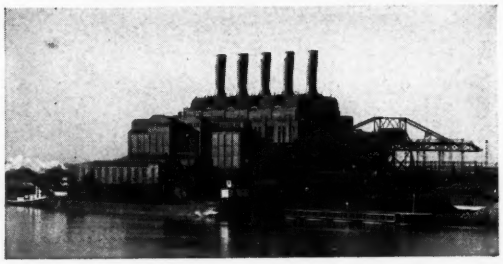
In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact, its absorption is less than 1 per cent. . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

"PENNSYLVANIA"



The performance of two large "Pennsylvania" Bradford Breakers at this Station, installed in 1923 and 1926, has again proven the endurance and low cost operation of this type, in service where unfailing dependability is a "MUST."

As a result of this performance, duplicate Bradfords were installed in a later Station of the same system.

Over 60 of these Bradford installations are in Central Station service in the U. S. A.

"Pennsylvania" Bradford installations, at home and abroad, now have capacity for preparing well over 100,000,000 tons per annum.

Performance data will be furnished on request.

New York
Pittsburgh
Chicago
Los Angeles

PENNSYLVANIA CRUSHER COMPANY

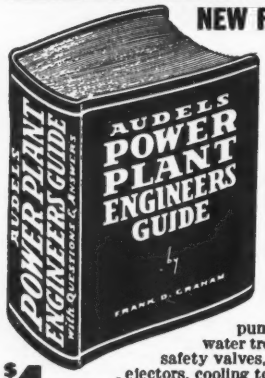
Associated with
Fraser & Chalmers
Eng. Works,
London

1706 Liberty Trust Bldg., Philadelphia 7, Pa.

COAL PREPARATION

AUDELS
POWER PLANT ENGINEERS GUIDE
WITH QUESTIONS AND ANSWERS

NEW FROM COVER TO COVER!



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A Complete Steam Engineers' Library in One Book!
1500 PAGES—65 CHAPTERS
1700 ILLUSTRATIONS. FULL INDEX

1001 FACTS AT YOUR FINGER ENDS!

PRACTICAL INFORMATION IN HANDY FORM FEATURING:

Basic principles of Steam Engineering, including Boiler Construction, Operation and Repairs. Gives practical information on Boiler Calculations, fuels, feed pumps, water heaters, economizers, water treatment, injectors, traps, draught, safety valves, oil burners, stokers, condensers, ejectors, cooling towers, evaporators, steam and hot water heating, pipe fitting & tubing. Contains complete data on all types of Steam Engines and Turbines, Indicators, Valve gear, Valve setting, Air Compressors, Hoists, Gas and Diesel Engine Operation, Lubrication.

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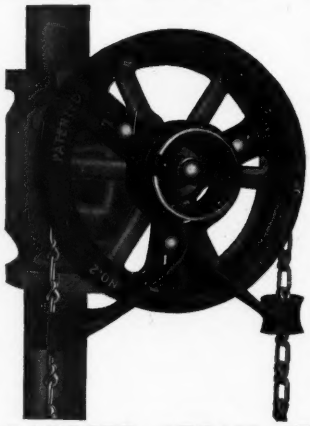
Do Away with Dangerous
LADDER WORK

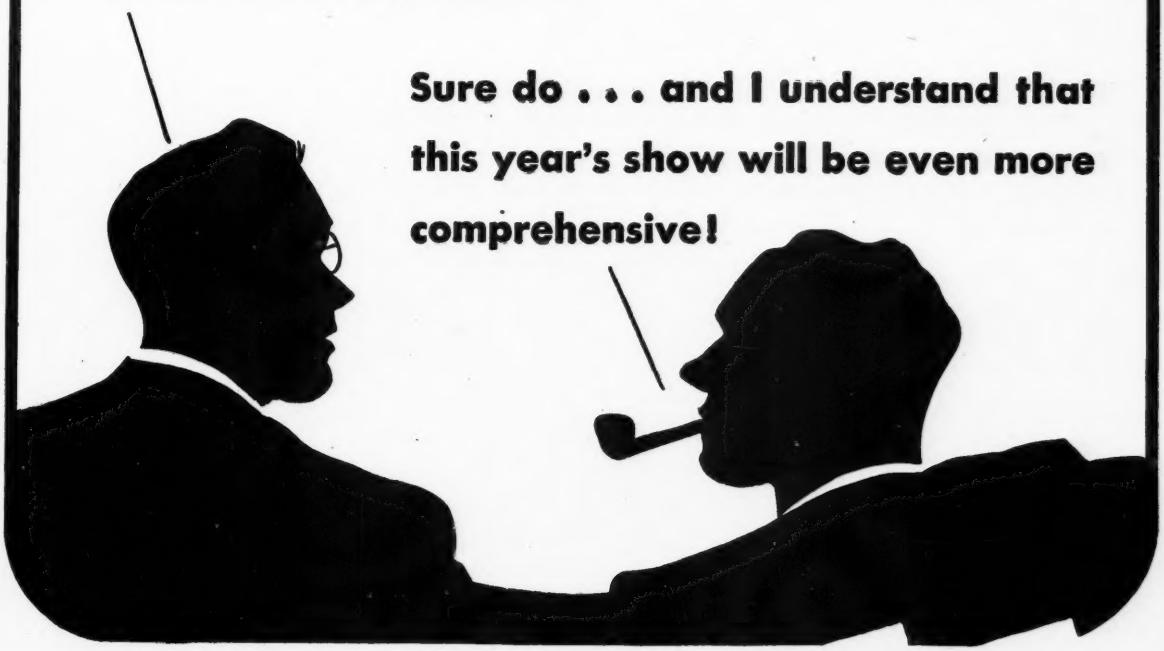


Stop climbing ladders to open and close those "high-up" valves. Equip them with Babbitt Sprocket Rims and you can control them quickly and safely from the floor. Babbitt Rims are easily attached and low in cost. They show real savings in time and steam—help guard against accidents. Now is the time to fit your overhead valves with Babbitt Rims. Write today for further information.

BABBITT STEAM SPECIALTY CO.
South Water, Spring and First Sts.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

Remember that idea we picked up at the last Power Show?



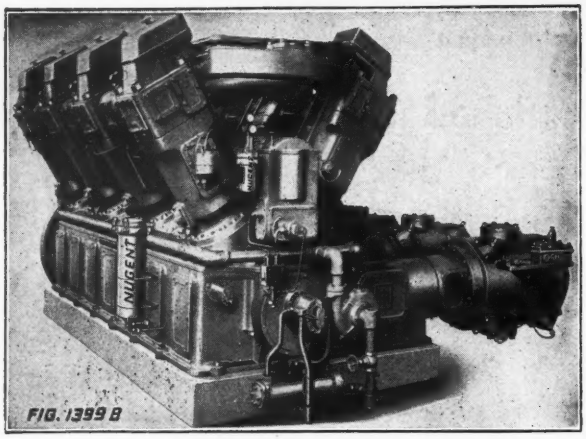
IDEAS? Yes, there will be plenty of them in the 350 exhibits at the 1946 Power Show. Production ideas . . . maintenance ideas . . . *money-saving* ideas. Come and see what the nation's leading suppliers of power equipment are doing and thinking about. Talk to specialists at the informative exhibits.

The Power Show is for *power men.* General public not admitted. Admission by registration. Reserve the date. Be there with your associates.

1415

17th NATIONAL POWER SHOW

GRAND CENTRAL PALACE, NEW YORK • DEC. 2-7, 1946



(Above):—Ingersoll-Rand 8-cylinder 10½" x 12½" Diesel-driven air compressor unit, equipped with Nugent Filters for lube oil and Diesel fuel. (Right):—Close-up of the type of Nugent lube oil filter used on the above unit.

NUGENT TRADE MARK

Compressor Efficiency INCREASED with NUGENT FILTERS

Helping Ingersoll-Rand protect its famed reputation for compressor efficiency, low maintenance and long life are Nugent Filters, used to filter lube oil for compressor units, as well as fuel and lube oil on Diesel power units. By depending on the proved design and dirt removing ability of Nugent Filters, I-R compressor crankcases can remain sealed, completely protected against damage from foreign particles. Diesel engines used for powering these compressors are doubly protected by Nugent Filters, as both fuel and lube oil are kept practically 100% clean all the time. Let Nugent engineers help solve your filtration problems.

Nugent Filters

ESTABLISHED 1897

WM. W. NUGENT & CO., INC.

422 N. HERMITAGE AVENUE CHICAGO 22, ILLINOIS

Fuel Oil Filters
Lube Oil Filters
Lubricating Systems
Sight Flow Indicators
Oiling Devices

FYR-FEEDER MULTIPLE SPREADER STOKERS

Available Now!

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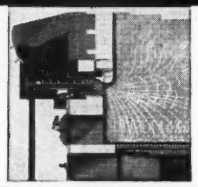

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FYR-FEEDER Multiple SPREADER STOKER
IT'S EFFICIENT
IT'S AUTOMATIC
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MAGIC BOILER PRESERVATIVE

—WON'T EVAPORATE OR DISTILL OVER

"MAGIC" Boiler Preservative has the big advantage of being non-volatile. It will not evaporate or distill over with the steam.

The steam from boilers using "MAGIC" is pure and free from any chemicals or injurious gases. It can be used directly in processing industries without injury to products.

Remember, too, that "MAGIC" puts a protective film on the iron which not only prevents scale from adhering, but also helps to prevent pitting, corrosion and leaks.

GARRATT-CALLAHAN CO.

Established 1904

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OF NEW YORK, Inc.
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OF CALIFORNIA
148-154 Spear St.
San Francisco 5

Twelve Years of Trouble-free Service—
—with CRYSTOLON BRICK

(left) CRYSTOLON Brick after three years of service in a school boiler furnace look the same as the day they were installed.

(right) Unretouched photograph of the same CRYSTOLON Brick after 12 years of service. When soot was scraped away, the surface of the brick was found to be in perfect condition.

CRYSTOLON Brick are densely made of silicon carbide plus a minimum of a refractory bond. These highly refractory brick are physically rugged, chemically inert and resistant to abrasion. Coal ash slag cannot penetrate the hard, dense surface of CRYSTOLON Brick and this makes clinker removal a short, easy operation as well as guaranteeing long, trouble-free service.

NORTON COMPANY—Worcester 6, Mass.

NORTON Longer Lasting REFRACTORIES

Final inspection of Rempe made, seamless steel coils for a chemical plant. Coils 2" Grade A-106 tubing, tested for 8000 lbs., hydrostatic pressure.

Rempe

BUILDS QUALITY

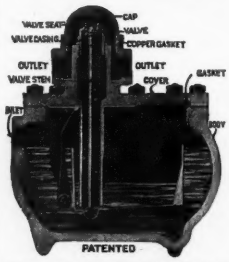
HEAT TRANSFER EQUIPMENT

AT A SAVING!

Without any obligation on your part, send or bring us your heat transfer problem, large or small. Prompt attention and estimate. We are specialists of long experience in Coils, Welded Pipe Assemblies, Supply Headers—all purposes for which bent pipe is used. Also designers and builders of Heat Exchanges, Feed Water Heaters, Coils for Refrigeration, Chemical Processes, etc. Wire or write.

REMPE COMPANY
344 No. Sacramento Blvd., Chicago 12, Ill.

THE GENUINE Squires STEAM TRAP



saves your fuel bill as it operates **without** loss of steam.

May we send Catalog E-9 giving complete information.

The C. E. SQUIRES CO., Cleveland, O.

Care-Free Maintenance

of water level in your heaters, tanks, reservoirs and other equipment avoids a lot of operating headaches in these days of peak production and man-power shortage. Hercules Seamless Copper Floats have been doing that kind of job for 50 years. With 666,000 of them now in service, each sold under a full year's guarantee, we know what they've done, what they will continue to do. If YOU don't know, it will pay you to find out by putting a few of them to work in YOUR plant.

HERCULES FLOAT WORKS

200 Franklin St. Springfield, Mass.

BLACKMER ROTARY PUMPS are COST CUTTERS

HAND PUMPS and POWER PUMPS are SELF-ADJUSTING FOR WEAR

The "Bucket Design" swinging vanes automatically compensate for wear. When the "buckets" finally wear out, a simple replacement job restores the pump to normal capacity.

THIS MEANS LOWER PUMPING COSTS!

Write for Bulletin No. 306—Facts About Rotary Pumps

BLACKMER PUMP COMPANY
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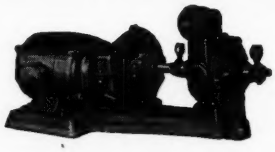

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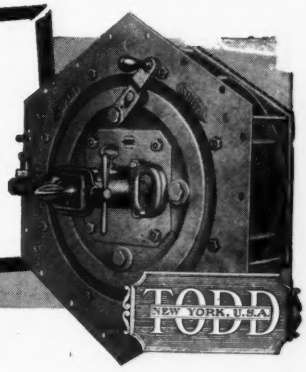

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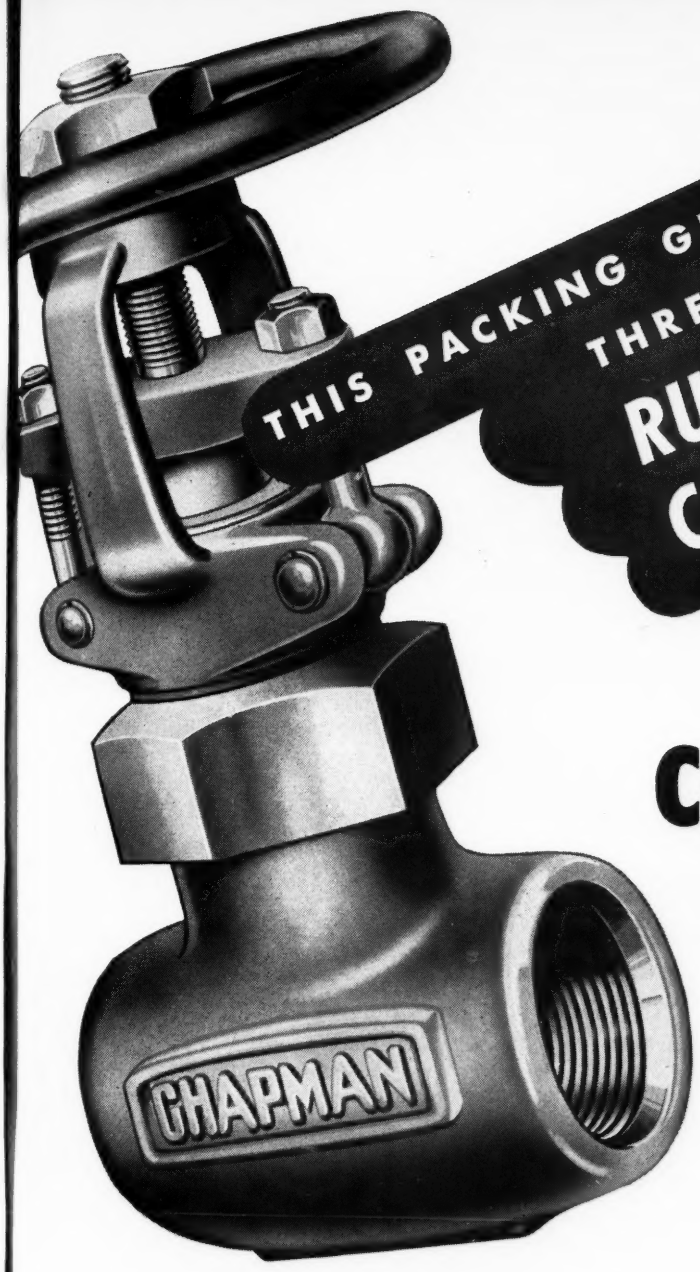

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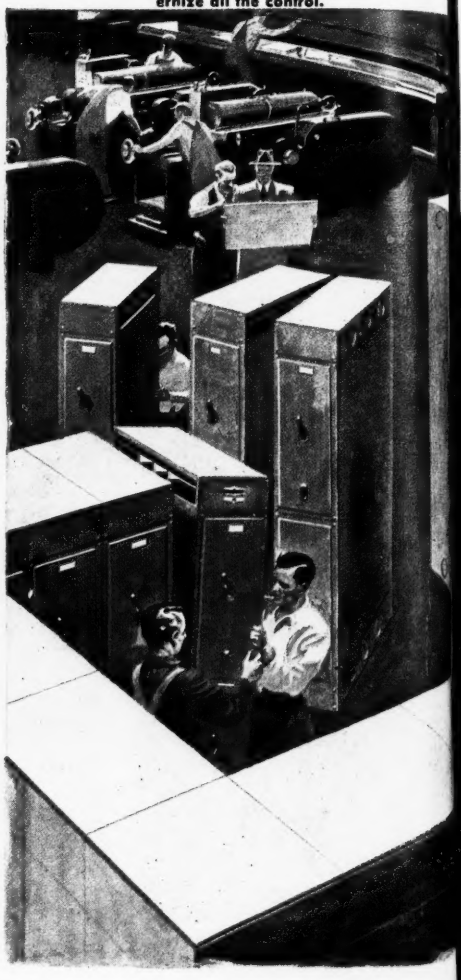

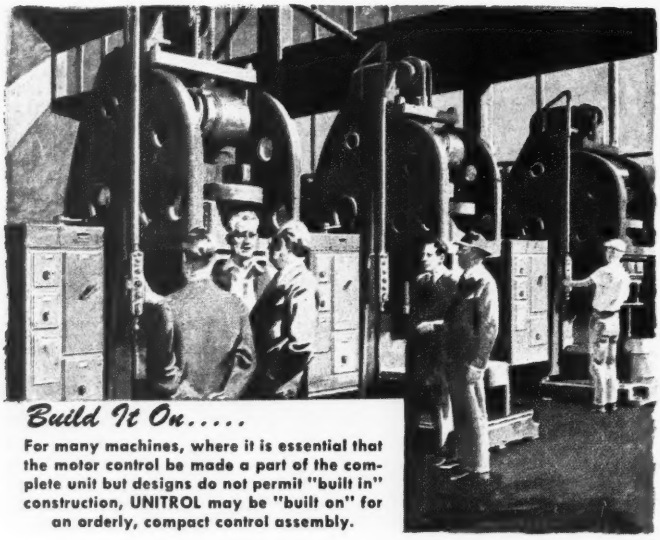

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